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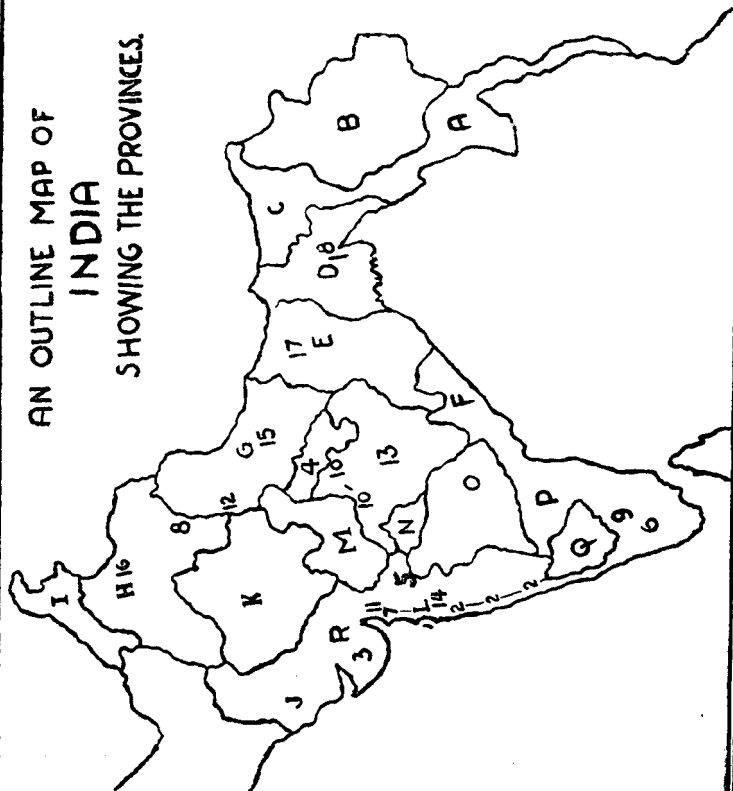
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AN OUTLINE MAP OF INDIA SHOWING THE PROVINCES.



- A. Lower Burma.
- B. Upper Burma.
- C. Assam.
- D. Bengal.
- E. Bihar.
- F. Orissa.
- G. United provinces.
- H. Punjab (including Delhi).
- I. N. W. F. Provinces.
- J. Surat.
- K. Rajputana including Ajmer Marwara.
- L. Bombay.
- M. Central India.
- N. Berar.
- O. Hyderabad State.
- P. Madras.
- Q. Mysore State.
- R. Kathiawar.
- 1. Surat.
- 2. Bombay Ghats.
- 3. Kathiawar.
- 4. Bundelkhand.
- 5. Khandesh.
- 6. Coimbatore.
- 7. Gujerat.
- 8. Delhi.
- 9. Nilgiris.
- 10. Vindhya.
- 11. Baroda.
- 12. Agra.
- 13. Nagpur.
- 14. Poona.
- 15. Cawnpore.
- 16. Lyallpur.
- 17. Pusa.
- 18. Calcutta.

PREFACE

The author acknowledges with thanks the permission given by His Majesty's Stationery Office, London, to utilise in the writing of this book material which he had provided for the book 'Indian Social Welfare' published under the direction of the India Office.

R. G. ALLAN.

FOREWORD

In 1937, Sir Edward Blunt who edited the book published under the title "Indian Social Welfare" invited Mr. Allan to contribute for it the portion relating to agriculture. The survey contained in that volume is an admirable introduction to the social and economic problems of India : and the welcome which has been accorded to it shows that it has met a widely felt need. As the aim of that book was to cover, however generally, the whole field of the social services organised by governments in India, the space that could be allotted to "Agriculture" had to be limited in relation to the general scheme. Mr. Allan had prepared a longer and more detailed account of Indian agriculture in seven chapters which formed the basis for the condensed account appearing in the two chapters in the "Indian Social Welfare" allotted to the subject. I read this fuller account in manuscript and suggested to Mr. Allan that it should be published, as it gives a birds' eye view of the fundamental problems of Indian agriculture, a useful and necessary background for the study of the problems relating to individual areas. Mr. Allan kindly agreed and the present book is the result.

Mr. Allan has been Director of Agriculture in two Provinces in British India and now holds a similar position in an Indian State. His experience of agriculture in India is thus very wide and he has

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CHAPTER I

THE DISTRIBUTION OF CROPS

Crop distribution in India, factors governing regional and local cropping; regional influences and their bearing, temperature changes, rainfall and humidity, soil origin, influence of man; local influences, the system of farming position, communications and castes.

In dealing in the space of a few chapters with the agriculture of a tract about the area of Western Europe it is necessary to restrict what may be written to the broadest outline, at times thereby treating as universal matters which are in reality subject to innumerable minor variations as the resultants of differences in climate, soil and custom. A great deal of what is grown has been grown, though the varieties in evidence to-day may not be those in the past, from times immemorial and in many tracts the actual practices, modified to local conditions and by the slight changes which man's ingenuity over a long period of time has contrived, indeed the whole system of farming as we now find it, have been established practices and have remained unchanged for hundreds of years.

We will therefore, in opening, survey briefly the principal crops on which the Indian cultivator, according to the position of his holding, concentrates his time and efforts and the means at his disposal for the achievement of his ends—the maintenance of himself and his family—, passing on later to the difficulties with which he has to contend and the steps taken over the passed three quarters of a century and still being taken to aid him in this fulfilment.

The diagram, extracted from the Agricultural Statistics of India as applied to

The principal crops and their distribution. British India, gives us the principal crops.

Rice 80.4		Wheat 27.6		
		Jowar 21.4		
Gram 14.9	Bajra 13.1	Barley 6.7	Maize 6.1	Fruit and Vegetable 4.8
		Ragi 3.5	Sugarcane 3.9	
Other food crops 33.5				
Cotton 15.8	Jute 1.9	Rape and Mustard 2.9	Sesamum 3.7	
	Fodder Crops 10.8	Linseed 2.1	Ground nut 4.5	
Other non-food crops 7.0				

Other food crops are pulses other than gram, minor millets, condiments and spices.

Other non-food crops are oilseeds and fibre crops other than the above, drugs and narcotics and miscellaneous inedible.

Total area cultivated in British India 267 million acres.

Unshaded represents area under food crops in British India, 217 million acres.

Shaded represents area under non-food crops in British India, 49.5 million acres.

The total area of the country is 1,112 million acres. Of this 667 million lie in what is known as British India and this diagram accounts for 232 million as utilised for arable farming, some of which is double cropped thus raising the sown area to 267 million. The actual area under the plough is about 35%. The rest of this section of the country is devoted 13% to forests, 23% to land totally unfit for cultivation and the balance, about 30%, covers current fallow (7%) and cultivable land not yet under the plough (23%). In theory this last represents the area of future expansion. In actual fact very vast areas so classified could not come under the plough without the expenditure of enormous amounts of capital. We may say that the distinguishing feature of most of this class is that it is level. Much of it is in need of drainage, suffers from alkali, lacks water, is definitely malarious or so shallow as to be unfit for much except minor millets. Those of which the

disability is climatic, as measured by the shortage of rainfall, represent the more hopeful, as hundreds of thousands of acres which 60 years ago would have fallen in this class have been converted to fertile tracts by the help of irrigation, the most striking of recent date being the development now possible in Sind with the completion of the Sakkar Barrage. Examining the diagram shows us that over $\frac{4}{5}$ th of the total area is devoted to the food crops, required to support a dense population. With the exception of rice, and that only the production of Burma which is included in this statistical diagram, and of recent years but a small quantity of wheat, little or none of this produce is exported. As it is, a substantial fraction of Burma rice finds its way on to the main Indian market. Such export as exists is almost entirely confined to the 'non-food' crops.

The cropping of the cultivated area of any individual village is governed by two groups of influences which may be classed as regional and local.

The factors affecting crop distribution.

In the former certain of these are natural, the most important being changes in temperature, the amount and distribution of the annual rainfall and the origin whence the surface soils are derived, while others owe their existence to man. Of these the chief are the rectification of the vagaries of the rainfall by extensive irrigation developments, the growth of industries and the introduction of new crops or new types of an existing crop. These between them decide what crops it is possible to grow and to a certain extent which will pay.

The actual selection of the crops which will suit different fields and their greater preponderance in one village as compared with another are dependent on local factors. These may vary in local importance, but the more decisive are the system of farming prevalent in the area, the plentifulness of easily tapped sub-surface water supplies, the position of the field on the local contour, a factor governing to no mean extent the depth of soil and its ability to retain moisture, the nearness of the fields to the village, the character of local communications or the ready availability of markets and to some extent the presence or otherwise of certain castes.

The fact of regional distribution is evident on examination of the statement showing the general appearance of the main staples provincialwise, even though this statement is incomplete, in that of necessity it generalises under crop heads without bringing out that under any one head there are a number of varieties of markedly different character. The influence of the factors recorded above as affecting crop concentration may with advantage be briefly summarized and their respective effects traced.

The first of these is temperature variation. If we draw a line across India starting near Surat on the west coast travelling up the Tapti to Khandesh and then eastward to Nagpur, thence bearing slightly north-east so as to pass about 100-150 miles north of Calcutta we divide India into two parts. Roughly the area to the north of this line

DISTRIBUTION OF PRINCIPAL CROPS IN
Figures in

Crop	Madras	Mysore & Hydera- bad	Bombay & Bombay States	Central Provin- ces & Berar	Bengal
CEREALS					
Rice ...	10.5	1.7	2.4	5.6	21.5
*Wheat ...	...	1.2	2.1	3.7	.15
*Barley ...	...	...	...	...	.09
Juar ...	4.8	9.3	10.0	4.3	...
Bajra ...	2.8	2.3	5.3	.1	...
Maize ...	.7	.7	.17	.15	.07
PULSES					
*Gram (Bengal) ...	.07	? (a)	.7	1.2	.2
OIL SEEDS					
Groundnut ...	3.2	1.2	1.5	.18	...
Sesamum ...	.75	.6	.5	.5	.16
Castor ...	.27	.9	.09	...	...
*Linseed ...	...	.3	.12	1.1	.12
*Rape ...	...	...	...	.06	.71
FIBRES					
Cotton ...	2.1	1.8	5.8	4.2	.05
Jute ...	...	...	...	...	2.1
OTHERS					
Sugar ...	.12	.1	.1	...	.3
Tobacco ...	.26	.1	1.6	...	.3
Tea ...	.07	...	...	...	.2

BRITISH PROVINCES AND LARGER STATES

Million Acres

Assam	Orissa & Bihar	United Provin- ces	Sind	Pun- jab	Remarks
4.8	13.	6.6	1.1	...	No figure implies below 50,000 acres. (a) the figure given in crop records is 2.0, but includes another species of pulse, also called 'gram' and is thus left out so as not to confuse remarks in the text on regional cropping.
...	1.2	7.7	1.0	9.2	
...	1.3	4.0	...	.7
...	.07	2.4	.04	.8	
...	.07	2.1	.8	3.0	
...	1.7	2.1	...	1.1	
...	1.5	5.5	.3	4.7	
...	* Rabi crops.
...	.2	.25	...	...
...	
...	.6	.8	...	...
.34	.6	2.6	.1	1.1	
...	...	.7	.8	2.5
.15	.24	
...	.45	2.147	
...	1.4	.0808	
.43	

has a definite and appreciable cold season while in the south the cold weather is scarcely recognisable or very short lived, unless the area happens to be relatively high lying and inland. There are roughly speaking two main sowing seasons June-July and October-November. The majority of the crops of the first sowing mature between October and December; those of the latter from February to May. The first are termed the Kharif, the second, Rabi. The difference between Kharif and Rabi crops is definitely marked north of the line.

The crops starred on the list are invariably sown with the opening of the cold season. They are temperate or semi-temperate species and it will be noticed either do not occur, or if so, in much smaller amounts south of the line. In the Central Provinces which the imaginary line divides practically all the sowings of such of these crops as appear in the province are found north of the line. The same holds to some extent in the Bombay Presidency. Wheat appears to be a partial exception, but this is partly the resultant of elevation and partly because the dominant variety south of the line is different to that north of the line. The wheat in the peninsula is largely Macaroni (Durum) and that to the north is Bread (Sativum) wheat.

Further, if any of the unstarred seed crops are going to appear in the north they must be sown between April-May (if irrigation exists) to the end of July. After that, except in one or two varieties of Sesamum, which can be sown in September just

north of the line, it is too late. On the other hand given moisture in the peninsula, with increasing emphasis as one goes south, any of these crops or at least certain varieties, if not all varieties, can be sown any time.

The south is invariably warm. In the centre, as in Hyderabad, the tendency is rather more towards a continental climate and the temperature runs higher in the summer and falls lower in the winter. This with elevation accounts for the inroad of semi temperate crops in a partial degree into this tract. With the movement of the sun over the equator heat again gradually floods northern India and the temperature rises often to heights untouched in the peninsula and with this rise, given moisture, the tropical species can re-establish themselves. In most tracts the essential moisture comes later with the break of the rains in June and till this occurs very little can be done. But it may be noted that in many respects the varieties found in the north are essentially earlier maturing. Thus cotton is found in appreciable amount in every tract except Bengal, Orissa, Bihar and Assam, but the cotton to the north, growing on the natural rainfall and sown in June-July, is for the most part a short staple type of about 5 months duration. Such indigenous longer staple cottons as exist, for the most part associated with a longer growing period, are to be found south of this line with the exception of a certain extension north of Surat in Gujerat where for about 100 miles on its close association with the sea the climate has a more tropical tendency.

Sugar-cane is essentially a tropical crop, though at first sight this is not indicated on the table; but here other factors controlling regional concentration, to be discussed later, play a prominent part. The sugar-cane of the south is a very different crop to that secured or at any rate as was secured till of recent years in the United Provinces. It is a longer growing, heavier yielding and thicker cane with a much higher sugar return per maund than anything to be found even to-day north of the peninsular area.

Of the oil seeds, ground-nut may be regarded as essentially tropical, though there is nothing really to prevent its spread at any rate into areas like the United Provinces, where on the whole labour is plentiful and the rainfall is not excessive. Till but relatively recently it was more or less restricted to the red soils of Madras and Hyderabad. The extensive movement into areas like Khandesh in Bombay and into the Central Provinces as a rotational crop with cotton, is of recent date and to some extent must be associated with the introduction of erect growing, small seeded, earlier types as opposed to the later maturing, trailing, bold seed forms as dominant in the red soils. If it was not for the earliness and easier lifting of these newer types, it is extremely doubtful whether ground-nut would have ever got a footing as a subsidiary crop to cotton in the stiffer black soil tracts.

Castor, it will be noted, only appears to any extent in the south. Here it tends to be a field crop and can be assessed. It appears, however, fairly plentifully, but in a scattered condition, in many

parts of the Gangetic valley and it is probable that a very considerable quantity is actually grown, if the sum total of the few plants on hundreds of thousands of small holdings could be assessed on a field basis. It is however essentially a warm climate crop.

Linseed demands on the whole a cooler condition and is concentrated in the north of the Central Provinces, in the Bundelkhand division of the United Provinces and in Orissa which abuts on it. It is grown very largely on water retained from the monsoon by the heavier classes of soil, those usually devoted to the growing of rabi crops in these tracts where irrigation is not available, and it is to be found on the Gangetic alluviums in the sub-montane tracts of the United Provinces and Bihar.

India depends on the monsoon or seasonal rains.

Rainfall and humidity. The most important over the largest area is that termed the south-west which, coming in on the air currents of south-west winds of the hot season, bursts over the country usually in June. The early stages are marked by rain storms along the west coast and in falls in Burma, the Assam hills and to some extent in lower Bengal which may occur in April-May. Finally the moisture laden winds, as it were, effect an ascendancy over the dry air which has occupied most of the upper part of peninsular India and Northern India for several months, and on this, depression after depression sweeps in either from the Arabian sea or the Bay of Bengal and different tracts from being essentially

arid become classable as humid or semi-humid or semi-arid in accordance with the amount they receive.

This carries on till the latter part of September, occasionally a little later, when the direction of the main winds changes and flows from the north-east. From thence onwards except for occasional and very welcome showers, known as the christmas rains, prevalent primarily in north-west and affecting the Punjab plains, the sub-montane districts, the United Provinces and in a lesser degree north Bihar, the majority of India can count on but little or no rain till next June. The exceptions are Madras, particularly the east and south, the south of Hyderabad and the southern Maratha country which get what is known as the north-east monsoon and receive thereby a very substantial assistance. The coast lines, the south of Madras, lower Bengal and Assam enjoy or otherwise according to the outlook an oceanic somewhat humid climate, showing but little change of temperature throughout the year. In the rest of India the climate for 8-9 months may be classed as continental, dry and with a more or less marked temperature difference between winter and summer and day and night. With the coming of the monsoon the whole country, but to varying degrees, adopts the condition prevalent on the coast line and for 3-4 months it can be described as oceanic.

The amount of rain which a tract receives and to some extent the dates and character of the early rains have a very considerable influence on the

dominant crops. Rice for instance, if grown without irrigation, requires a very considerable rainfall, anything from 50" upwards. Cotton, juar and bajra on the other hand do not thrive, if the rainfall exceeds 40" and a great deal of shorter staple cottons prefer 25" if reasonably distributed. Maize and jute germinate best, when the temperatures are high, and are most intolerant of excessive rain in the early stages, though the latter in particular can stand considerable amounts when once established.

These facts account for certain concentrations. Rice can be grown in peninsular India, as explained earlier, at almost any time, if moisture is available. It is freely available in the coastal regions of Madras and is further helped out by extensive irrigation works in the deltas of Godavari and Krishna which enable not only different sowings but the growth of the later maturing and better types. The valley of the Ganges, aided by the Himalayas, as an area of level plains and high rainfall, at its maximum in Bengal within the tropical zone, and falling off as one moves up the valley to the United Provinces, is a tract which lends itself to rice, though, as we pass to the north-westward up the valley, except in the closely sub-montane districts, a shorter warm period and a declining rainfall causes earlier coarser paddies to predominate. The rice tract of the Central Provinces abuts on Orissa and, if it does not secure quite the rainfall of Bengal and Bihar, gets a rainfall which renders cotton, juar and bajra impossible but is sufficient for the effective cultivation of the coarser and earlier types.

In Bombay rice is almost entirely concentrated on the narrow coastal plain between the Western Ghats and the sea with a rainfall of from 100" to 200". Once the Ghats are crossed the rainfall falls off sharply to 30" and under and we pass abruptly from a humid to a semi arid climate, to a different soil and to the region of cotton, bajra and juar. It will be noted that 55 million acres of rice are practically speaking concentrated along the east coast and round the head of the Bay of Bengal.

Another concentration in this latter area, primarily governed by rainfall considerations, is jute. Practically the whole crop, as will be seen, is confined to Bengal, Assam, Bihar and Orissa. The crop can be grown in Madras, in the United Provinces and even in the Central Provinces but it is not. In one respect the concentration is connected with rainfall. The tract usually receives substantial showers in April and May in advance of the main monsoon. This permits the easy establishment of the crop before the real rains set in, an essential factor. In the other tracts this condition can only be produced artificially. Other factors which must not be overlooked are the presence of ample water for retting, the big industrial concentration on jute manufacture and the ready market of an easily grown crop under local conditions with little or no long distance transport costs.

The requirements of cotton, in particular the dominant short staple varieties, the earlier types of

ground-nut and several of the kharif pulses, juar and bajra are the exact opposite to those of rice. They occupy for the most part those tracts which we may term semi-arid and where the rainfall is not persistent and where the drainage is good. They may occur in the same provinces as show a fair paddy cultivation but they rarely show in the same districts. Thus in the Central Provinces we find substantial areas of both cotton and rice but one dominates the west and the other the east.

We may thus put it that rising temperatures make it possible to grow varieties of species whose home is in the south almost anywhere in India during the summer; but it is the effectiveness of the monsoon, in the absence of irrigation, which decides whether it will be some variety of paddy or cotton, juar or bajra or, may be even one of the minor millets, dependent on the rainfall over the tract and the behaviour of the soil to that rainfall.

The essentially humid tropical tract in the south-west of the peninsula is the home of most of the spice crops like pepper, cardamum and the like.

The soils of India in the widest sense can be fairly simply classified in accordance with their origins. There are five main groups, though it must be understood that within each there are numerous actual agricultural soils in the farmers understanding of the word. In four of the groups the fact as to whether the soil is suited to this or that crop is essentially a local matter

and depends on the position on the contour on which rests the retentivity of the soil to water and its fertility and hence its adaptability to this or that crop. In short, except in certain cases, the position of an area of country relative to other tracts is for the most part of far greater importance than the rock origin whence it has been derived. In the fifth group which may be termed "the alluvial soils" i. e. those owing their existence to river deposition, there is naturally marked variation dependent on the character of the rock whence erosion and flood have derived the load of mud which has subsequently passed to soil.

Beginning in the south we have what are termed
 The red soils. the red soils of Madras derived from the erosion of the

archean schists and gneiss of the uplands of that area. These are responsible for the soils of south Madras, Mysore, south and east Hyderabad and south-east Bombay. On the uplands, as of Mysore and the like, they give rise to a thin reddish soil usually fit only for the minor millets, the predominating one being Ragi, (Elusine Coracana), a millet confined almost entirely to the south of the country. As we pass to lower elevations the soil darkens in colour, deepens and increases in fertility and crops like cotton, ground-nut and the like and finally in the well watered tracts rice appear. The red, red brown loams and clay loams are definitely fertile and those of fair or good depth respond to irrigation. The soils are deficient in organic matter, nitrogen and phosphoric acid.

In a sense ground-nut, the later maturing and bolder seed types, take kindly to this soil and to some extent we must attribute the preponderance of this crop in this area to the soil. Another influence on cropping is noted in cotton, the types found containing a number more closely associated with American species than with Indian. In the earlier days of cotton improvement in India American cottons were tried everywhere in the then accepted cotton tract, but, at any rate in so far as the peninsula is concerned, it was only on these rather opener and less sticky soils that they established themselves.

Passing to the north-west we come on soils derived from trap, an area covering over 2,00,000 square miles in Bombay, Berar, the west of the Central Provinces and Hyderabad and appearing in outliers in Central India and Kathiawar. The tract is for the most part one of low rainfall. The typical soil from this formation is a black clay loam, with a marked retentivity for water and a characteristic of cracking badly when the water is evaporated in the dry season. As in the first group mentioned, position plays a very prominent part in soil values from place to place. The country is broken by small hills and is undulating. In the upper cultivated slopes the soils are thin and the commonest crop is bajra. As we pass away from this we come to soils of 3'-4' depth, containing a greater or lesser amount of lime nodules and underlain by decomposed trap. This is the typical black cotton soil of India which occupies extensive tracts and gives rise to the enormous areas of relatively short staple cotton and juar shown

in the table. At the bottom of the slopes and in the deeper valleys the soil depth increases to 10'-20'. Nodules are absent and even with the relatively low rainfall they become in many tracts unworkable in the rains and much too water-logged for cotton or juar. They are thus sown in September and October with rabi crops and it is this soil characteristic which gives rise to the considerable area of linseed, wheat and gram, grown without irrigation, which we find in the Central Provinces and parts of Central India, and to the extension of these crops south of the general line dividing tropical and sub-tropical India, the elevation above sea level of much of the tract providing the necessary colder conditions required for these crops. The soils like others in India are deficient in organic matter and nitrogen but usually have ample lime and a sufficiency of soluble phosphates. Except in isolated areas where the soil is of moderate depth and underlain by an effective layer of shaly decomposed trap, where vegetable cultivation under wells flourishes, they do not, unlike the red soils, respond to irrigation.

There is no tract in the country in which the soil character plays a great part in deciding the regional cropping of the area than we find here. With the generally low rainfall of the tract, bajra and certain pulses and even early ground-nut might come to maturity on other soils; but cotton and later and better juars would not have the areas they hold nor could the considerable extensions of rabi crops be possible, whatever the temperature, under the rainfall common over the tract, were it not for the particular soil to which the trap gives rise.

Leaving this area we move eastward across the Central Provinces. In the centre we have a strip of rather

The laterite soil. lightish soils derived from the Gondwana formation which apart from responding to irrigation has no distinctive bearing on cropping. Eastward of this we have a large tract covering the eastern half of the Central Provinces, Orissa and North of Madras and working right round the head of the Bay of Bengal into Assam, broken in places by stretches of modern alluvium, which are termed the laterite soils, as derived from laterite, itself in all probability a resultant of the weathering of igneous and metamorphic rocks under conditions of high rainfall and temperature. These soils contribute to the major part of the rice area of India. Whether it can be said that the rice concentration in this tract is directly influenced by the soil, as apart from the climatic condition, is less certain. The soil produced however is of a character which rice appreciates, as this crop for the most part does not enjoy stagnant water. Ample water and a humid atmosphere it enjoys, but the water must be able to circulate as by drainage and this the classes of lateritic soil under paddy permit. In the more undulating area away from the coastal belt, as in the Central Provinces, paddy occurs on the lighter grades of those soils but in the hollows where drainage is less perfect and the soil is finer and heavier, rabi crops, as in similar conditions in Western India, make their appearance. Were the soils of Western India to be transferred to this tract round the head of the Bay of Bengal, it is more than probable that rice would not have the

unlimited expansion it now has in this area. The soils as a whole are deficient in organic matter and nitrogen and not infrequently in lime and usually respond to phosphatic manures.

North of the Central Provinces we have the Vindhya and other considerable outcrops of crystalline rocks, occupying part of Bundhelkhand, certain States in Central India and part of east Rajputana. On the whole the soils are lighter than those in South India. A great deal of it is poor country given over to grass. Cropping is governed largely by rainfall and the possibilities of irrigation.

Finally there remain the alluvial tracts which are by far the most extensive and agriculturally important. The alluvial soils. They occupy the greater portion of Sind, Gujerat, Rajputana, the Punjab, the United Provinces, Bihar and Bengal in the northwest and east of India, appear again in the extensive deltaic tracts associated with the Godavari, Krishna and Tanjore districts of Madras, and exist as a strip of soil along the eastern and western coast lines and appear along the courses of many of the great rivers of Peninsular India. With a spread of this kind and with varied sources of formation their qualities are far from uniform. On the whole they are fertile, are not too dense in consistency, are naturally drained and lend themselves on this account and on the score of flatness to the extensive irrigation schemes, associated in particular with Northern India. Apart from this it is somewhat difficult to attribute special regional crop distribution directly

to alluvial soils. They may be said to provide excellent media on which crops suited to the climate or aided by irrigation, whether by wells, which are usually easily secured, or canals, can grow effectively.

The most important of these in India is undoubtedly the creation of irrigation facilities in tracts in which the soil lends itself to this. Of the various ways by which water deficiency can be made good, the canal systems of India, in particular those of Northern India, provide the largest regional effects. Were it not for these in the Punjab and Sind, little of the large development of wheat recorded against these areas would be visible, as, however suitable the temperature, the rainfall over the majority of the area outside the sub-montane districts is entirely insufficient. Wheat can be grown in the United Provinces without irrigation, but here again the extension of area and the yield obtained must be credited to its extensive canal systems.

Again even if cotton is to be found in parts of the Punjab and even Sind in the absence of irrigation, its existence accounts for the extensive area of the crop and has undoubtedly given rise to the early sowings of April and May and hence to the wide spread cultivation of the longer staple American types in both the tracts.

Sugar-cane in the United Provinces is another example. It is true that low water lifts and the relatively humid climate of the sub-montane districts have tended to make sugar-cane a frequently grown

crop, but its very extensive appearance, in particular in the western districts, must be attributed primarily to the Ganges canal. Other factors have undoubtedly contributed towards the present-day concentration, but it is primarily cheap water which has been responsible for the wide expansion of a crop which is essentially at its best much further south.

Maize provides a fourth example. Its prominence in Orissa and Bihar is, as in the case of Jute, to be attributed to early rains before the oncoming of the main monsoon; but its somewhat extensive appearance further north is very largely based on the use of canal water in the latter part of the hot season.

The canals of the Punjab, Sind and United Provinces between them irrigate over 16 million acres, while wells in these areas account for another 9 million. The influence therefore of this method of improving on what is provided by nature is very considerable. In all some 55 million acres are aided or protected throughout British India by artificially provided water, just short of a quarter of the total cultivated area.

Man has also contributed to the regional expansion of crops in other ways. Many of our farm crops have several species within which are varieties and again types which have their particular economic features under varying conditions of soil and climate, as adaptability to certain soils, early or late maturity, higher yield and a dozen or so different characters which make them suitable for this or that requirement or condition. The wide

spread cultivation of cotton from Madras in the south to the Punjab in the north is undoubtedly due to the multiplicity of forms, one or other of which meets local conditions. There is no doubt that the discovery and introduction of a variety or type suitable to a certain tract does at times result in the marked regional appearance of a new crop or in an intensity of its cultivation. Possibly the most striking of these is the development of ground-nut on the black soils of Khandesh and the Central Provinces where the introduction in 1912-13 of an early maturing easily harvested type, both matters of very considerable importance in this area, has led to an expansion from a negligible area of about 2,000 acres of the older forms, chiefly irrigated, to its cultivation on an area of over 6,00,000 acres as a dry crop.

Other examples which are worth record are the wide expansion of Coimbatore cotton in South India, an American type by chance introduced in 1905, the similar extensive expansion of American cottons in the Punjab and Sind, aided no doubt by irrigation but fostered by the creation of higher yielding and better acclimatized forms, and lastly the changes created in the sugar-cane of Northern India by the new types created at the Sugar-cane breeding station at Coimbatore. This work has led to almost the entire replacement of the older, thin, low yielding, indigenous forms in evidence 15 years ago by types capable of an increased yield by 50%, to the expansion of Sugar-cane in the United Provinces from less than 1.5 million acres to over 2.2 million and to making the sugar industry, established chiefly here and in Bihar, an economic possibility.

The last factor operating on the regional development of the cultivation of a particular crop is industrial development. This factor, as compared with those already mentioned, has no influence in deciding whether a crop can or cannot be effectively grown, but it does contribute to the particular large scale distribution of a crop which other factors make possible. The best examples of this influence are the influence of the Jute Industry in Calcutta on the concentration of jute in Bengal, the influence of Bombay and Ahmedabad on the almost excessive utilisation of land in cotton in Gujerat, the effect of better ginning and pressing facilities in Berar on the concentration of cotton in this area and its general reduction in other parts of the Central Provinces and finally, as already mentioned, the stimulus to sugarcane expansion in the United Provinces and Bihar following on the revival of the Indian Sugar Industry and its concentration in this tract.

Regional factors decide what crops can be grown.

Local factors influencing cropping.

They may, as in the last case above, give the indication as to what will be most readily marketed; but the actual appearance either of the main staples or of the many others which regional factors admit in one village as compared with its neighbour or in the different fields into which it is divided are dependent on local conditions. The most prominent have been mentioned earlier. Taking these in the order recorded, the general system of farming is of considerable importance. Briefly there are two, farming for family support or self-sufficing farming

and farming with the market in view or commercial farming. The first seeks to provide as much as possible of the family needs from the holding. It therefore implies the cultivation of many crops in small quantities. The latter implies a concentration on one or two commodities for market disposal, with the other subsidiary crops under cultivation, very largely as leading to the improvement of the money crop or as reducing its cost. This system implies the dependence on the market for a larger percentage of home necessities. Over the larger part of India with its small holdings and the influence of the past, weak communications and the like, farming is still definitely self sufficing. The farmer grows relatively little of any one product. After paying the rent, for which he may and does include some commercial crop, his chief concern is the food supply of his family and his live stock. In such tracts there must therefore be a relatively high proportion of such food grains as will thrive and even at times the cultivation of certain crops which may not be actually the most paying but which are called for by home needs. Their placement on the holding will be influenced by other factors but the general effect over the village is that of a patch work quilt. Again an examination of the fields will show that most sowings are mixed, partly to get the necessary variety, and partly, it is true, as a species of insurance against unfavourable weather conditions and as a method of providing the effects of crop rotation. Except possibly where influenced of recent years by the sugar industry most of the farming of the Gangetic alluviums and South and Central India may be said to be self-sufficing.

At the other extreme is the outlook, for instance, of the Gujerat or Berar farmer, farming on the better grades of soil, whose sole consideration is his cotton crop or in some places his tobacco crop. Here every acre which can go under the money crop does so upto perhaps, in cotton, even two thirds of the holding and the village area has the aspect of being one field of cotton cut at times by lines of an alternate crop, usually a pulse, and broken here and there by scattered fields of juar or bajra, the prominence given cotton in one village as compared with another being dependent on the proportion of land which can by hook or crook grow it.

Where farming is self-sufficing the proportion of the several available crops is governed to a considerable extent by family need. As it passes towards being industrial farming allotment is perhaps more governed by relative productivity. All the next three factors, as mentioned earlier, bear on productivity as governed either by water availability or soil fertility.

In the alluvial tracts, but outside the areas provided with water from canals or tanks, irrigation is from wells. Where these are plentiful the more valuable crops dominate. Suitably placed there may be resource to vegetable crops, chillies, onions, sugarcane, spices or wheat or cotton depending on location and the other staples are given a back seat and relegated to the fields in the holding outside the irrigated area. In northern Gujerat one may quite easily find one village plentifully provided with water and the next dependent almost entirely on rainfall.

Both may be in the same soil and in a like climate but in one it will be a matter of wheat, better quality cotton, spices like cumin, with a certain amount of irrigated fodder, in the other primarily bajra and early maturing pulses.

When one passes to black soil tracts and even to some extent to the laterite and the red soils, but possibly more marked in the first, position is the all important factor governing depth of soil and hence fertility and water content, unless as in the red soils irrigation is able to assist. On the black soil in a village having a dominant proportion of its soil heavy deep clay loam, the land will be per force down in wheat, linseed and gram. At the other extreme on the contour it may be but a cultivation of bajra and urid and a little poor cotton. In between it is a cropping almost entirely of cotton interspaced with juar. If one travels across the laterite soils of the east of the Central Provinces the influence of position is fully apparent. Sparce grass on the tops passing to minor millet, then to a zone of early rice, then to a zone of later and better rice and ending in the hollow in a mixture of rabi crops, wheat or gram predominating, and as the farmers fields are placed so is he compelled to sow. The farmer in the alluvial has a rather wider latitude of choice. The fields near the village, given that they suffer from no physical defects, are usually those planted out with the better crops of such collection as Nature and conditions allow. This is but natural. They are in receipt of such little manure as his cattle or humanity provide. Incidentally they get more of the owners ready attention.

Transport and the distance to a market have their influence on cropping. Round the bigger towns, given that the soil permits, market garden crops are given better prominence. Even places well removed from big central markets but on the railway line cultivate and export appreciable amounts of cold weather vegetables, potatoes and the like. Cotton shows up in declining quantity when haulage exceeds 40 miles and land which if nearer the market would be under cotton is devoted to juar and bajra according to its quality.

Lastly caste has at times some part in the village cropping scheme. Certain castes as for instance Kachhias tend to concentrate on vegetables. A Kachhia's village or one in which they are numerous, given the opportunity, will be largely given over to a miscellaneous collection of market garden stock. Apart from specialities of this kind certain castes are very much better farmers than others. In general good farming conditions tend to be linked with a predominance of the better farming castes in the village community. Where this is the case under like conditions there will be found a definitely higher proportion of such crops as call for greater care, attention and skill, or in other words the better priced staple crops of the tract.

CHAPTER II

SOME OF THE PRINCIPAL CROPS

Rice, wheat, cotton, jute, sugar-cane, millets, pulses, oil seeds, tobacco, fruit, covering characteristics, distribution, development, striking features or differences in cultivation, improvements, present day position and utilisation.

Rice

This crop occupies 38% of the total cultivated area, giving a gross yield of 30 and 32 million tons. The varieties of this crop are innumerable. It is thus not difficult to get types suited to almost any soil, climate or water condition. The finer qualities are long, thin, sharp pointed grains of a yellow to golden colour; the actual content (commercial rice), nearly white, translucent, hard and pointed and often scented. The coarse forms are usually bigger, darker coloured and less pointed, the rice thick, white and opaque. There are all manner of grades. The time taken to mature varies from very early to late. The former are usually the coarser forms growing under less favourable rice conditions.

For the most part rice is sown once a year after the break of the monsoon, though in Bengal it appears as a late spring sown crop *aus* as well as at the more normal time (June-July) when it is known as.

aman. On the irrigated tracts on the better soils of Madras rice may appear three times in a year on the same field.

Except in a few areas, as on the heavy soils of Gujerat where it appears as an inter-line crop with cotton, rice is grown in flat beds surrounded by low embankments. A great part of the rice area depends on river silts to maintain its fertility. The crop responds to heavy manure like cattle dung, compost and green manuring. This last under steady demonstration is of recent years a much extended practice, where either early rains, as in Bengal, or irrigation in the hot season, as in Madras and in the United Provinces, make it feasible to sow San (*Crotalaria juncea*), Dhaincha (*Sesbania*) or like leguminous crops for this purpose. The major part of the rice soils suffer from lack of phosphates but, again of recent years under departmental demonstration, the application of phosphatic manures, generally bone meal, is increasing.

The crop is either broadcasted in fields after preliminary cultivation after the break of the rains, when normal seed is used, or broadcasting is delayed till subsequent cultivation has cleared the weeds and puddled the soil. In this case artificially germinated seed is used; otherwise it is either drilled or raised on seed beds and transplanted. Drilling is restricted to parts of the west coast. The two principal methods are broadcasting and transplanting. The former is usually in evidence in the coarser earlier forms where the probability of sufficient moisture at the end of the season may be doubtful.

Transplanting undoubtedly gives much heavier crops, but calls for a very large labour concentration over a short period of time. It is thus not always economic.

The yield varies considerably in different tracts, different soils and under different methods of planting. Given a suitable condition i. e. ample rainfall, a soil which permits the water to pass slowly through it, and transplanting, 2,000 to 2,400 lbs. per acre is a good average crop. On the other hand when broadcasted and under poorer conditions even 600 lbs. per acre may be accepted.

Paddy has always received a considerable amount of attention from departments of Agriculture in areas where it is important. This has taken the form primarily of selection from the many natural forms, studies in manuring and crop handling. Of recent years, the crop has been taken up for active research by the Imperial Council of Agricultural Research and there now exists a chain of special research stations throughout the whole of the rice growing area devoted to the evolution of better types for local conditions and to a more exact study of the conditions under which it grows and hence steps to ameliorate these.

The crop in so far as India, exclusive of Burma, is concerned is mostly consumed in the country. Export though not confined to Burma is very largely concentrated there. The amount exported has varied considerably from year to year since the beginning of the century, the peak years being 1912-13 and 1925-26 when it exceeded 2,500 thousand

tons. Of recent years it has been below the 2,000 mark. Approximately 90 % of this is from Burma. The principal importing countries have been Ceylon, Germany and British Malaya and Japan in increasing amount.

Wheat

The crop occupies about 10% of the total area and provides about $9\frac{1}{2}$ million tons a year from an area of 34 to 36 million acres.

There are two principal species *Triticum sativum*, the normal bread wheat of Europe, and *Triticum durum*, at times termed Macaroni wheat. The former occupies the largest area, the latter appears chiefly in the south, as a dry crop on the heavier black soils as in the Central Provinces and Bombay. The Indian wheat crop is grown either as a dry or irrigated crop, being sown from October to the end of November as local conditions bring the temperature down. All the crop of the Central Provinces, Bombay and Hyderabad is a dry crop grown on the heaviest classes of black soil on water stored therein during the monsoon. It rarely gets rain during the growing period, though it is helped, as are all rabi crops in India, by copious deposits of dew. In the United Provinces and the sub-montane districts of the Punjab it appears as a dry crop but usually gets some assistance from winter rains.

The irrigated wheats are mostly in evidence under the canals and well irrigation of Northern India. About half of the Punjab crop and all the Sind crop is entirely dependent on this facility.

It not infrequently appears as a single crop, specially in Northern India, but for the most part it is grown mixed with either gram, linseed or safflower on the black soils and with gram and barley with cross lines of rape and mustard on the alluvial soils. The seed rate varies from 60 to 100 lbs. per acre. In all areas except in the heaviest alluviums of the Central Provinces the primary cultivation accorded wheat is of a high order. Under dry conditions a yield of 800 lbs. per acre may be regarded as good; under irrigation one may expect 1100 to 1200 lbs. if adverse conditions do not intervene.

The crop has received continuous attention from the department of Agriculture since it was initiated. Most provinces at the present day have evolved improved strains to meet many local variations in soil and climate. Pusa, the Imperial Research Station, now head-quartered near Delhi, has been instrumental in creating a number of types which have a wide acceptance in the Gangetic valley. The Punjab has been the next biggest producing centre of improved wheats. Though a certain amount of progress can be made by the introduction of the improved types of one area into another, the general indications are that the best can only be got by breeding to the special needs of a tract. Between six and half to seven million acres are at the present day under improved types which did not exist 20 years ago.

Shortage of rain, absence of the usual dew and matters of this kind may lower the total yield, but by far the greatest enemy of wheat are the fungi termed the Rusts, of which there are three distinct forms, red,

yellow and black. Each contains a greater or lesser number of physiologic forms, indistinguishable to the eye but distinguishable as attacking this or that wheat type. With the outbreak of an attack the wheat crop gets covered with the spores of the attacking form, the vitality of the plant is heavily reduced and the yield of seed and size of grain are materially affected. It is most in evidence on irrigated wheats and, if February is cloudy and damp, causes crores worth of damage in a bad year.

Recent important research has shown that infection does not carry over from year to year in the plains, but originates annually from foci at altitudes of 5000'-7000' in the Himalayas and the Nilgiris where there is no closed period of wheat growing. Created there the spores are carried annually to greater or lesser extent over the plains of India, inducing attack where wheats susceptible to the form appear and climatic conditions assist. To control the foci in the Himalayas is difficult, to do so in the Nilgiris is relatively inexpensive. The principal direction of meeting the infection must lie in the breeding of types of economic value, resistant to infection, by no means a rapid procedure, though certain reasonably resistant types have been created.

Export of wheat for the passed few years, though showing some recovery recently, has been negligible. Indeed between 1932-35 India was on the balance of export and import an importing country. The export trade has always fluctuated. From being invisible in 1900-01 it rose to over 2,100 thousand tons in 1904-05, fell to barely 100 thousand

in 1908-09, fluctuated between 700 and 1,500 upto 1917, for the next year or two was again negligible, but rose to about 1,000 thousand tons in 1924-25 from which year it has been low.

India indeed has exported wheat when the absence of famine or of local scarcity made it feasible. The low export of recent years may be credited to increased home demand and to the fact that prices have ruled higher in India than on the overseas, principally United Kingdom, markets. With the big expansion of this crop in Sind and the Punjab, resultant on new irrigation schemes coming into operation, it is probable that she will again appear as an exporter.

Cotton

As a cotton producing country India stands next to the United States. In several provinces and States it is the main money crop. The area varies from year to year. In 1929 it was 27 million acres and in 1932 22½ million acres. It fluctuates between these. The potential area is about 30 million acres. Grown from very ancient times, centuries of acclimatization and natural selection in indigenous cottons and efforts in the past to introduce exotics and modern plant breeding have left a track of varieties and sub-varieties suited to one or other cultivable area where it appears. In the past its function as providing the wherewithal for clothing to be woven on the village hand loom made its cultivation a necessity in almost every village. The import of cheap foreign mill-made cloth, the curtailment of the hand loom industry, the development of internal transport and a big export demand have between them helped its large scale

commercial cultivation and have tended to its concentration. With these forces operating a new force has come into being—the Indian mill industry—and with it, as years have passed, the need for the cultivation and expansion of the longer staple varieties have come more and more to the forefront. 20–25 years ago, before the close of the European War (1914–18), the Indian mill industry for the most part wove the coarsest forms of cotton cloth for which cottons giving 8 to 10 counts were good enough and the necessary premium on better staple, an essential in view of the fact that in general the lint yield is less, was scarcely obtainable. At the present day these Indian mills spin 30 and 40 counts and indeed import cottons which will give this and hence the bias in improvement has largely gone over to improving the general spinning value of the cottons grown. India is however still largely a short staple country i. e. the majority of the cottons with a staple less than $7\frac{7}{8}$ ". About three quarters may be so classed. The balance is predominantly medium staple, $7\frac{7}{8}$ " to 1". The average production over the last decade has been 5,200 thousand 400 lbs. bales.

Cotton interests are controlled throughout India by the Indian Central Cotton Committee, constituted in 1921 and given legal status under the Cotton Cess Act of 1924. The Committee is financed by a cess on the bale outturn of the country. This body, embracing spinners, ginnerers, growers and agricultural department representatives, command an annual income of about nine lakhs.

It has been entirely responsible for the fostering of most of the research and plant breeding work of the last 15 years, the extension of these results into agricultural practice, the control of cotton marketing by legislative measures and constructive action and the provision of information to agricultural departments, the trade and general public.

As has been indicated, cotton is grown in India under

Distribution. more varied climatological and environmental conditions

than any where else. The species, varieties and types are very extensive. Though commercially dominant in the drier tract, varieties are to be found, though of poor quality as in the Assam Hills, under rainfall of 75" to 125" with a temperature range of from 70"-80". In the Indus and Gangetic plains covering about 4 to 4½ million acres we have two marked types, the 'Bengals', a short staple, growing largely under natural conditions i. e. sown in June-July with the rains and the 'Punjab and Sind Americans' a medium staple, the product of the canal watered areas. To the south of the above lies the Malwa plateau north of the Vindhya range, standing at about 1,500' above sea level and forming a distinct cotton tract growing a short staple but under different temperature and moisture conditions to the area north and east of it. This tract is the home of a short staple species, the Neglectums, which subsequently spread with great rapidity into Khandesh, Berar and the Central Provinces, as a hardy, high ginning type, in the period when quantity definitely paid the cultivators. It very largely indeed ousted

the better species of short staple. To the west of this lies Gujerat in which the predominating species are Herbaceum cottons, late varieties planted in July and not picked till March-April. A great deal of this is $7/8''$ staple and some passes into the medium staple class. It is the most important herbaceum tract in India and provides about $3\frac{1}{2}$ to 4 million acres.

The rest of the peninsula can be considered as one extensive tract, the 'Deccan,' divided into three distinct sub-tracts. The northern covers east and west Khandesh, north Poona, Ahmadnagar, Sholapur, the Berar, the west of the Central Provinces and the north of Hyderabad. The soil is entirely derived from trap. The crop is almost entirely grown on a monsoon $25''$ to $40''$ between June and the end of September. It is a quick maturing crop picked by November-December and is, except for a few isolated exceptions, a short staple. It represents about 10 million acres of the total crop. To the south of this lies the catchment area of the river Krishna covering south Hyderabad, Karnatak (Bombay), northern Mysore and certain northern Madras districts. The rainfall varies from $20''$ to $40''$. The important feature is that the basin stretching across the peninsula secures both monsoons. To the north we find rain fed early cotton and to the south, as getting the north-east monsoon, the rain fed late types. The early cottons are sown in July-August and picked October-November, the late in September and picked February-March. Finally in the south we find an area dependent

primarily on the north-east monsoon, sowing being done in September-October. There is a considerable amount of well irrigation. The medium staple cottons of India outside those grown under the canals of Northern India and in the deeper and wetter soils of Gujerat appear here and in the better rain-fall areas of the Krishna basin. The soils carrying the long staples are either one of the alluvials or the red soils.

The improvement of Indian cotton has been fitful in both its object and methods.

Conditions influencing improvement.

In the latter part of the nineteenth century the motive was the production of cotton suited to the needs of Lancashire and the method of its attainment was by the wide-spread introduction of longer staples from other countries. The Dharwar American and the present day Coimbatore cottons owe their origin to this. Apart from those on the red soils these attempts then met with little or no success. The last part of that century and the opening of the present one witnessed an increasing demand for cotton from Indian mills and later Japanese mills. This demand was for cotton of any kind—not medium or long. The demand grew rapidly. The difference between the price of short and medium staple declined. This probably contributed to the rapid spread of the short staple $5\frac{7}{8}$ " neglectum varieties referred to earlier and there is no doubt that prior to the Great War (1914-18), the recently started departments of agriculture, with the best profit to the cultivator in view, concentrated on high ginning rather than staple. This condition held till about 1920.

Since then there has arisen (a) a definite Indian mill appreciation for superior cotton (b) an uncertain foreign demand for short staples, and hence for the last 15 years or more the efforts of the Cotton Committee, Agriculture Departments and plant breeders have been directed to an improvement in staple, working within the cottons in the country. As the result of this nearly every main tract has two or three very definite better varieties available and indeed at the present time considerable tracts are sown with these. The main objects behind this work have been better yield, better fibre and greater resistance to disease and insect pests.

Little need be said in regard to the methods of cultivation as these vary too much to be dealt with precisely. In regard to the fertilization of the crop it may be noted that the value of farm yard manure is for the most part realised and when it is available it is applied; though this does not mean that manuring is widely resorted to. In South Gujerat it is usual to give 5-6 tons per acre every 5 years, in Khandesh $2\frac{1}{2}$ to 5 tons. In the case of Dharwar American it may get 8 to 10 tons every four years. In the Karnatak it is usually applied to the juar crop at the rate of 2-3 tons. In the irrigated tracts as Coimbatore, the Punjab and the U. P. manuring is usually given indirectly to the previous crop at the rate of about 5 tons to 7 tons, if available. In general manure in the Central Provinces, Berar and Sind and elsewhere is not used as extensively as it should be.

In no part of India has the use of fertilizers become common, as not even on experimental farms have the results been conclusively paying. The uncertainty of the rains, specially in the rain fed tracts, causes investment in top dressings of nitrogenous fertilizers to be too speculative.

Over most of peninsular India the crop with which cotton usually rotates is either juar or bajra, the latter on lighter soils. Of recent years, as in Khandesh on the black soils and in parts of Hyderabad and Madras, the tendency is to a three course rotation of ground-nut, cotton and juar. In Northern India and in the United Provinces it rotates with cane and wheat while in the Punjab the rotation is wider, and toria, gram and sugar-cane may precede cotton, with wheat also in the rotation.

Sowing practice varies considerably. In the Punjab, Sind, the United Provinces and southern Madras the crop is broadcasted. Drilling is but a recent introduction which is becoming a practice in certain areas. In the United Provinces the crop is not infrequently mixed with pulses and sesamum, the cotton being thinned out to 2' to 2½' spacing. In most of the other areas thinning is for one reason or another not done, though in the Punjab the plough is run once or twice through the crop to thin and hoe it.

Over the rest of India the seed is drill sown, the space between the lines varying from 14" to 18". Only the best cultivators thin. In Gujerat spacing is usually wider, ranging from 3' to 5' and at times even 6'. In the wider spacing usually a line

or two of some subsidiary pulses or even paddy fills the ground during the rains. Irrigation, except in very small scattered areas, is not practised on the black soils. In the Punjab about 92% of the crop of 2.2 million acres is irrigated. In the United Provinces about one third of a crop of about 8,00,000 acres, while in Sind almost the entire crop is watered. Irrigation again appears as a common practice in certain areas in the red soils—notably the Coimbatore area—with about 1,75,000 acres so treated.

The provision and maintenance of pure seed of improved strains is a more difficult problem than for better seed to the growers. The provision of improved strains is a more difficult problem than for example it is in the case of rice or wheat. Cotton is open to cross pollination and again, as most of the commercial crop goes to the ginneries, there is a vast possibility that seed issuing therefrom for next year's sowing is not pure. If this is continued without attention, it is not long before an improved type in steady cultivation deteriorates. In the older days the grower not infrequently hand-ginned his next years seed. This does hold still to some extent in the more isolated areas. Under these conditions seed once issued may be kept in like condition for years; but this is dying out. Now-a-days the cultivator sells his whole crop and buys his seed from the ginnery or elsewhere.

To meet this the only thing is an established seed organisation whence seed of a high standard can continue to flow out every year for the use of the ordinary farmer. This is organised in most seed extension schemes as below:—

- (1) A small area of cotton of the approved variety is planted out. On this area the seed is selfed i.e. it is prevented from cross pollination.
- (2) Its product passes on next year to sow either the whole farm or part.
- (3) This product is expanded to cover the whole farm or to provide selected growers round the farm, the crop being cared for and ginned under the farm control.
- (4) This passes out to certified seed farmers, where it is again under observation during growth and the ginning, now at an ordinary ginnery, is specially looked after.
- (5) Their produce is taken by unions; groups or co-operative sale societies and, though possibly not so carefully watched in the field stage, it is specially ginned so as to ensure purity. In the next year this provides the seed for the commercial sowings of the tract. Roughly one acre of selfed seed in the first year suffices for 10 acres in the second, 100 in the third, 1,000 in the 4th and provides for 10,000 acres of group sowing thus passing out seed for 1,00,000 acres of commercial crop. In certain areas where the seed rate is very low, the expansion based on this initial unit will be higher.

In the cotton tracts control of seed is one of the most important functions of the Department of Agriculture. Eighteen percent of the total cropped area is by these means under improved types. Of this about sixty percent is medium staple.

Cotton is not a difficult or laborious crop to grow.

A comparative small outlay in bullocks, implements and labour (except at picking) covers a substantial area, but it is a crop which has to face some very definite enemies in the form of diseases and insect pest, which between them are capable of doing an enormous amount of damage to the crop of the country.

The most damaging diseases are two soil borne ones, Wilt in the heavier soil and Root-Rot on the lighter grades of soil. No means have as yet been evolved of combating them by alterations in agricultural practices, except that in the latter late sowings reduce the incidence. They are however being overcome by the breeding of types resistant to attack and fair progress has been made in respect of Wilt.

Of the insect pests the three most dominant, though fortunately not in the same tracts, are pink and spotted boll worm and Jassid. The two former can be controlled by physical means, if co-operative action is taken, and substantial progress in dealing with the second is now making head-way in Gujerat. The only defence against Jassid, prominent in the American cottons in the Punjab, is the production of resistant types. A considerable amount of attention has been given to these matters by the Indian Central Cotton Committee.

The crop measured in bales of lint is (a) exported
Utilization. (b) used in the Indian mill industry (c) consumed in sundry ways in the villages. This last has been the

subject of close enquiry by the Indian Central Cotton Committee, as there has always been a considerable divergences between the Government final forecasts based on acreage and estimated yields and the actual bales pressed throughout the country plus the loose cotton taken up by the mills. In part this divergence is due to incorrect estimates and in part to unknown consumption. Exhaustive enquiries put the extra village consumption at about half a lb. per head which gives about 4,40,000 bales.

The average cotton crop is about 52,00,000 bales, the highest of recent years being 62,15,000 in 1925-26 and the lowest 40,07,000 in 1931-32. The Indian mill consumption has risen steadily from 18,25,000 in 1923-24 to 26,70,000 in 1935-36. In the various trade groups, denoting roughly staple grades, the most marked increase has shown in the American types covering the Punjab and Sind and those under Dharwar-American and Cambodia. This has risen from 1,24,000 in 1928-29 to 7,61,000 in 1935-36. Another interesting rise, as indicating the trend of Indian spinning, is the increase under imported medium staple which has risen from 59,000 to 4,82,000 in 1934-35. Except for 1931-32 when the crop was short the amount exported has remained fairly constant at about 33,00,000 bales over the last 15 years. By far the largest customer of Indian cotton is Japan which consumes roughly 50% of the exported crop. One of the more interesting expansions is that of the United Kingdom whose demand from being in the 2,00,000 bale level was in 1935-36 over 5,00,000. This rise has been to some extent offset by the steady fall in Italian and Chinese demand.

Jute

As indicated earlier the crop is very definitely localised. The area in spite of this is subject to rather violent fluctuations. At the present time as the result of propaganda it is about 25,00,000 acre mark, but has often been well above 30,00,000 acres.

There are two forms in common cultivation. *Capsularis* and *Olitorius*. The land usually used is that subject to inundation as thereby manured, but in general any land in which rice grows well will carry jute. Tillage commences with the early rains and under this a fine dry crop tilth is produced. The seed is sown in April and May at about 8-10 lbs. per acre and a log is passed over the surface to cover the seed and smooth. Once established it is lightly harrowed. When once it reaches a foot or two in height it is uninfluenced by heavy rains, grows rapidly and reaches about twelve feet. The crop is cut for fibre before it is ripe i. e. just before the seed sets. After a few days in a stacked condition it is retted i. e. tied in bundles, and submerged in water. If the weather is warm this is completed in 21 days, when the bark is easily stripped and the clean fibre separated by washing in clean water and beating. The commercial value is governed by colour, lustre, strength, length and fineness. Careless retting is a common cause of inferior fibre, though this may at times be due to incorrect harvest, a poor quality type and matters of this kind.

The fibre is bought by petty middlemen and after passing through two or three hands

it reaches the baler. The price on the market is about 20% higher than that given the grower. Jute is marketed in 400 lbs. bales. With the acreage at about 25,00,000 the bales produced will be in the neighbourhood of eight million. In the middle of the nineteenth century the manufacture of gunny bags from jute centred in Dundee. At the present day the main focus of manufacture is in and about Calcutta where there are over 100 mills. Though a considerable amount of raw jute is still exported, less than about 6,50,000 tons goes out in this form, and the rest in manufactured goods. The principal individual buyers are the United Kingdom, Germany, France and the United States. In relative values manufactured jute is slightly more than double the value of exported raw jute. The period 1914-20 had a marked effect in establishing the jute industry in India financially. The export of both raw jute and manufactured jute is easily affected by any slump in the classes of goods for which it is used as containers.

An organisation similar to the Indian Central Cotton Committee has recently been established for this staple and is known as the Indian Central Jute Committee.

Sugar-cane

One third of the world's sugar demand is met by beet, the balance depends on sugar-cane. Approximately half of this is produced in Asiatic countries and of this half, India is responsible for rather more than 50%. In other words India provides one fourth of the sugar secured from cane and one-sixth of the total world supply of sucrose. This is at the present

day secured from an acreage of 40,00,000 acres. Ten years ago the area down under cane ranged in the neighbourhood of 25,00,000 acres only.

There were at one time two distinct types of cane

(a) thick, juicy and rather soft varieties calling for laborious cultivation and irrigation.

(b) thin, hard and less juicy types of much hardier nature.

Of recent years plant breeding has evolved types which though not so thick and juicy as those of (a), possess many of the characters of this group in their tendency to higher yield and richer sucrose content while possessing the character of hardness, the chief feature of the second group. It is this which has been primarily important in the expansion of cane in the last ten years.

Of these two great groups the first was associated almost entirely with Southern India, the thin, reed like varieties being associated with the extensive areas of cultivation found in the Gangetic valley. The more recent products of the Imperial Sugar-cane breeding station which began its work in 1912 have of recent years very largely replaced the canes of the past, in particular the sugar-cane of type (b). These, non-existent twelve years ago, now cover nearly two and a half million acres of the total area and eighty percent of the northern area. The fact that these canes are capable of a fifty percent higher yield under normal condition, and respond much more effectively to better farming accounts, with the increased area, for the rapid rise of sugar of recent years.

Prior to the oncoming of these products of plant breeding, improvement was sought by the introduction of varieties from outside India. With certain exceptions most of these were better suited to South India, the only exceptions in the north being the issue of two medium canes of Java origin and certain Mauritius varieties in the sub-montane tracts of the United Provinces and Punjab. Meanwhile active experimental work directed to the better cultivation and manuring of the crop and in improvement in the method of the production of gur (a combination of sugar and molasses, the form in which the produce of cane was and is still largely consumed in India) were in progress at Pusa and the other big experimental farms interested in the crop.

The cultivation of the crop varies enormously. In the south, chiefly under well-irrigation and under better growing conditions, the standard of cultivation and manuring are very high and very high yields of gur are obtained, 12,000 lbs. and more per acre being secured. Over the major part of the Gangetic area, the standard of farming is much lower and though yields of modern cane to the amount of 1,400 maunds of cut cane equivalent to 11,000 lbs. of gur have been secured, the average, even at the present day with better types, is nearer 4,000 lbs.

Usually the land in the better cultivated tracts is fallowed or put down in a green manure in the previous rains. In the following cold season it is subjected to frequent cross cultivation and a greater or smaller amount of manure is introduced according to local intensity. The crop is planted in the spring

from January to March though at times extended later into April but with marked reduction in outturn. This consists in planting out setts of the cane i.e. the whole cane cut up for the purpose into pieces, containing two to three buds and setting these in lines, some times on the flat and at others in more or less deep furrows or trenches. The distance between lines is governed by the fertility and the type of the cane. Usually under good conditions this ranges between three to four feet. In some areas the field is divided into small beds to facilitate watering, in others, in particular under canal irrigation, this is not done, the field being made as generally level as possible. Irrigation to some areas is given before planting at others immediately after. Little can be done till after the cane begins to show up when the surface is lightly broken up. From thence onwards to the opening of the rains watering and hoeing are the only activities, the latter not infrequently being defectively attended to. With the rains, comes the earthing up of the cane, converting the old furrows into ridges round the lines of the cane, then 3'-4' high. Nothing further is required except possibly tying up till harvest. The crop responds excellently to a mixture of cake and ammonium sulphate applied best in three doses, at planting, about 2 months later and at earthing up.

When ripe, a state which varies a good deal in different canes, some reaching their maximum sweetness in ten months and others requiring twelve to thirteen, the cane is cut. The juice is extracted by passing the cane through iron roller mills, operated by bullocks or small oil engines, and the juice, ranging in extraction

according to the cane and the efficiency of the mill from 60 % to 72 % of the total, is boiled, clarified and reduced to a semi-solid consistency in open pans where on cooling off it produces a more or less hard dry crystalline mass ranging in colour from a pale yellow to a dark brown, dependent on the sugar-cane used and the efficiency of the gur boiler. This is termed 'Gur', 'Gul' or 'Jagri.' Even at the present day seven tenths of the crop finds its market in this form.

The other forms of use of sugar-cane are direct chewing, which utilises a substantial fraction of the thicker softer types, sugar as made by the indigenous methods, which prior to the recent development of the factory industry, were estimated to be responsible for about 2,00,000 tons of actual sugar and white sugar as provided by the modern factory. Both of these enterprises buy whole cane from the growers. A cultivator will convert his sugar-cane into gur; but it is only on occasion, and if he is a fairly substantial grower, that he indulges in sugar making. The production of country sugar is confined to Northern India.

The process of making country sugar may be said to be related to that of gur. The juice is cleaned and boiled down in open pans in much the same fashion, though the boiling does not go on in one pan, the juice passing from one pan to another during the process of evaporation till it is brought to the right consistency under exposure to the greatest amount of heat. The product at this stage, called 'rab' is definitely more fluid than

when gur is intended. When this stage is judged as reached, the rab is poured off into earthen jars or kerosene tins and left. As it cools and time passes the sugar crystallises out in solid form leaving the molasses. When this is complete the whole is put into a centrifugal which removes the molasses leaving a yellowish sugar, which is washed with a little water while the centrifugal is still spinning and then removed and dried and powdered down in the sun. The molasses is again heated in a smaller furnace and subjected to a second cooling when another crop of sugar results, or it is boiled down and turned into an inferior quality of gur. The extraction of sugar is very low compared with the factory, as loss occurs in crushing and in extraction. A five percent recovery of sugar as compared with from nine to eleven percent, the mean recovery under factory conditions, may be reckoned as good average production. It is a process which is already dying out with the advent of the vacuum pan sugar factory and is only likely in areas outside factory influence and where cane is very cheap. Even when the factory in the United Provinces could pay 5 annas a maund for cane, the Khandsari open pan factories were unable to pay more than $3\frac{1}{2}$ annas.

In the very dim and distant past India was an exporter of sugar of this class, a trade which was abandoned when the British Government decided to foster the West Indies sugar in the middle of the last century. Later with the opening of sugar refineries for raw sugar in Britain a certain trade in raw

sugar or gur developed and refineries and sugar factories for a like purpose were established in India; but by the beginning of this century export had entirely ceased and India had become a steadily increasing importer of white sugar, in the first onset largely beet sugar but latterly cane sugar from Java where a high concentration of attention on improved cultivation and manufacture, aided by natural conditions, enabled much cheaper production than was then and for the matter of fact is even now possible in India.

Thus in 1930-31, before the onset of the slump which considerably reduced demand in the following years; India imported 10,00,000 tons of which over 8,00,000 came from Java while her home made product, country and factory, was about 3,00,000 tons. In 1932 the Government of India introduced its tariff restrictions against overseas sugar aimed at giving the Indian sugar industry, then a feeble one handled by about 29 sugar factories and a dozen others refining from gur and producing between them 1,30,000 tons, protection for 15 years.

The effect was enormous. In the eight years which have elapsed factories have increased from 29 to 171 and the estimated production of factory sugar is 9,10,000 tons and country sugar 1,25,000 tons, a total of 10,35,000 tons, against an estimated consumption of about 9,50,000 tons. In fact, unless demand increases for sugar as against gur, Indian factory enterprise has already to all intents absorbed the quantities normally imported 10 years ago and looks

like ousting the Khandsari production which is now estimated at 1,25,000 tons against 2,00,000 tons.

This industry is of mushroom growth and in the internal competition which must follow a certain number of factories are bound to go under.

The possibility of its existence rests on an improved cane and a heavy import duty. Its continuity or ability to stand without the latter rests on a cheapening of the cost of cane, an increased working season and greater factory efficiency. In Bombay and the south such sugar factories as exist are dependent almost entirely on factory grown cane. They thus can control their supply. In Northern India, except in a very limited degree, this does not exist and the factory is dependent on cultivators' cane. The factories of the north have further a very much shorter season of operation than those in South India and still more in Java where manufacture can be more or less continuous, whereas in the United Provinces a 150 day to 160 day season may be termed good. Thus, though a great advance has been made, a great deal has yet to be done in order to consolidate the new industry in the north where the majority of the factories are situated.

It is clear that the cultivator cannot grow cane at a loss. He judges his result by his profit per acre. At present a great deal of the cane is badly cultivated. The average yield is about 15 tons per acre. In Java the average is nearly 50 tons and in Bombay, using the highest, though possibly not the most economic intensity, yields of 100 tons per acre have been secured. The only way

to increase the return per acre is to raise the standard of the farming by putting better cane with the farmer, advancing him the money to invest in cake and fertilizer and by introducing him to better methods whereby, though the nett return per acre will be better or no worse, the price per maund at which he can sell to the factory will decline. Further with the issue of reliable seed there must be the issue of early, mid-season and late types so as to lengthen the factory season. Steps of this kind are being taken in the United Provinces so as to develop 2,000 to 2,500 acres of village cane round each factory and in the State tube-well areas by the creation of seed farms whence cultivators will get their seed, by the establishment of credit for standard cake and fertilizer mixtures and by the organisation of the day-to-day supply of cane by co-operative agencies to the factory in the amount required. It is only by strict co-operation between the factory interests and the growers interests that any real stability will be possible.

The Millets

There are several species under this general head, but juar or larger millet (*andropogon sorghum*) bajra or bulrush millet (*pennisetum typhoidium*) or Ragi or buckwheat (*elusine coracana*) have the greatest acreage. The last named is primarily confined to south India, the others, as shown in the earlier table, though wide spread, dominate the black cotton soils. Between them they provide the chief grain supplies of all areas outside the rice tracts and the main wheat blocks, covering an area

of over 56 million acres. Juar holds first place with 34 million, practically that of wheat, and bajra second on about half this area. The total supply of grain is about $9\frac{1}{2}$ million tons or practically that of the wheat crop. Only an infinitesimal quantity finds an outside market.

The first in particular has a number of varieties, varying in time of ripening and general grain and fodder values. This crop in particular has a distinct double value as the grain is of great local importance and its dried stalks provide the principal fodder of the tracts in which it is found. Certain varieties have a definite grain value, others a fodder value. A certain number of the latter are not infrequently grown entirely for those purposes only. A number of improved types suited to different conditions are now available or in current use.

Except in the northern area of the peninsular tract where certain types replace wheat on the heavier black soils as a rabi crop and further south where the area is under the south-east monsoon and thus compel September-October sowings, juar, and also the other millets are monsoon sown crops, harvested according to variety from October to December. Bajra has few varieties, the chief difference being relative earliness, absence or presence of awns and grain quality. Ragi is chiefly the millet of the poorer lighter red soils. About one third of the crop is in Madras and Mysore. In the latter it is the most important single crop and secures a good deal of attention from the local agricultural department. Bajra has its place on the poor grades of soil further

north and juar is usually found on soil of the better cotton types. There is not much to remark on their cultivation which generally consists of a couple of ploughings or two to three turns with the bladed harrow. Bajra goes in first, if there is any choice. Juar is usually sown after other kharif crops of the tract it is in. Both are drilled in the black soils but are usually broadcasted in the northern alluvial soils. In most cases the crops are grown mixed with some pulse. Except in Gujerat where the distance between lines is three feet the usual space is fifteen inches to eighteen inches, thicker and rather closer planting being in evidence when fodder is the main consideration. A reasonable return for juar is from 500 lbs. to 900 lbs. grain with 1,700 lbs. dry fodder per acre. The rabi sowings on heavy black soil give about 500 to 700 lbs. per acre.

The Pulses

These crops have a great dietary value in the balancing of a diet which largely consists of cereal grain. Some appear as kharif and others as rabi crops and the cultivation given is that of the cereal with which they are mixed, either in the row or in special rows through the main crop.

Arhar or tur (*Cyganus indicus*), Urid (*Phaseolus radiatus*), Mung (*Phaseolus mungo*) and Kulthi (*Dolichos biflorus*) are the principal kharif representatives. The first named has types which provide five to six month crops, chiefly found in the Deccan cotton soils, and others which hold the ground for eight to nine months are prominent in the Gangetic alluvium. Here it is usually mixed with juar and

after the harvesting of the latter in October, very largely for fodder, grows freely into a large bush type filling the field. Arhar is a hardy crop except for frost. It is a valuable plant in the way it aerates and fertilises the soil. Urid is very common as an interline crop with cotton in Gujerat. Kulthi figures on light soils and to the south.

Gram (*cicer arietinum*) is by far the most important pulse. It with lentil and lakh are the chief rabi species. The cultivation they get is usually that of wheat with which commonly mixed. If sown as a separate crop, they are put down on fields where for one reason or other the fine tilth or mulch called for by wheat is not possible. Gram appears frequently as a sole crop. It covers an area of about 16 million acres providing about $3\frac{3}{4}$ million tons.

The Oil seeds

These, though providing an important export commodity, can be best taken together. As has been pointed out ground-nut, castor and sesamum may be classed as tropical, though a good deal of the second is sown in the peninsula in the opening of the cold season. To these may be added niger seed, a somewhat poor quality oil seed found in considerable quantities in poorer hilly areas in the peninsula. Associated with these though apt to be lost in its fibre value we must include cotton seed. Linseed, rape and mustard are sub-tropical and rabi crops. With these can be included safflower which tends to take the place of linseed in the black soils

put down in rabi in parts of the peninsular section. A certain amount of sesamum also appears as an early rabi sowing. They possess a double value viz. oil and its residue, termed cake. With the exception of castor cake, which can be used as a manure only, the other cakes are edible. They provide very valuable proteids in cattle feed.

Though largely crushed for its oil in the United States cotton seed is crushed at one or two mills in India only. The vast majority of the seed is fed, usually after soaking, direct to live stock. In this form it provides the principal concentrate fed to animals of the cotton tract. The cultivation and the method of planting vary so much in detail from crop to crop, soil to soil and according to the season of sowing, that it is not possible to deal here with this feature. Ground-nut is generally a single crop as also is linseed in the black soils, though less so in the alluvials. Castor as a field crop is generally sown alone or with some early subsidiary between the rows. Rape and mustard occurs as the sole crop in the sub-montane tracts but much more frequently as a subsidiary to wheat. Sesamum, if appearing in lighter grades of soils, is invariably mixed with several other crops. When taken as a early rabi, sown in September in the black soils, it is usually a sole crop either broadcasted or drilled in a very shallow furrow.

The following figures indicate the area, yield and use :—

Name of the crop	Average acreage	Yield in tons	Recent export	Approx. used in India	Export prior to the war
Rape and mustard	59,00,000	9,60,000	78,000	8,82,000	2,77,000
Linseed	32,00,000	3,80,000	2,63,000	1,77,000	3,73,000
Sesamum	55,70,000	4,87,000	10,000	4,77,000	1,19,000
Ground-nut	57,40,000	25,50,000	5,00,000	20,00,000	2,12,000
Castor	14,30,000	1,28,000	79,000	49,000	1,14,000
Cotton seed	...	16,26,000	3,000	16,23,000	2,40,000

* Includes Burma with acreage 13,00,000 acres and 65,000 tons yield.

The oil seed which has shown the biggest expansion of recent years is ground-nut, reaching a figure of 32,00,000 acres. As compared with rape and mustard it is invariably a sole crop and is at the present day definitely the most important oil seed in the country. The ratio of export to crop is much less than is the case of linseed, which has always held a very high ratio as compared with other oil seeds. It is clear that relative to the position before the last war, though the total yield has either remained about the same or increased, the amount exported as seed, apart from ground-nut, is much less than it formerly was.

There is now-a-days far more crushing in India than there used to be. There has been some increase in the amount of vegetable oil and cakes exported, but the increase in the amount used for internal consumption either for food or industrial purposes is striking.

Tobacco

The plant was introduced in India in 1605 by the Portugese. Only two species are normally found in India, *nicotania tobacum* and *rustica*. The former is the common form. Left to seed it grows from five to six feet in height with very large leaves at the base carrying flowers white to pink and a fruit capsule which is egg shaped. There are a number of races in cultivation. The latter is chiefly in evidence in Northern India and Bengal and is a shorter growing plant with rather round and crinkled leaves, pale yellow flowers and a globular fruit capsule. The total area is about one and a quarter million acres, fairly well distributed but more in

evidence in Bengal and Madras. The annual output is about 6,25,000 tons. It is successfully grown on a number of soils, but is probably heaviest on alluvial clay loams situated near villages.

The nature of the irrigation water and the soil have considerable effect on quality. In the cultivation of soil for the average Indian requirements a thoroughly well tilled soil, treated with 25 to 30 cart loads of manure onto which the young plants when about 4"-5" high are transplanted, is usual. After planting it gets very steady hoeing. The general standard of cultivation is high. The vast majority of the crop is used in the country. Depending on the curing adopted after the leaf is picked, when ripe i.e. when brittle, crinkled and covered with yellow spots, it is either dark brown to black, or a yellow brown. Dark brown is the form used for hukka smoking, while yellow brown is commonly used for bidis. In so far as export is concerned the forms in which it left the country, till relatively recently, was as cigars and cheroots, chiefly made in Madras and Burma. As far back, however, as 1900 the import in cheap cigarettes was considerably greater in value than this export.

Of recent years a definite change has taken place on the realisation that virginia cigarette leaf could be grown satisfactorily in certain tracts of India, and if cured in special flue curing barns, could command both a considerable market in the United Kingdom and could be used to replace the cheap cigarette hitherto imported. At the present day 26 million pounds of unmanufactured leaf are exported valued

at 80 lakhs rupees. Meanwhile the import of unmanufactured leaf has fallen from seven million to three million maunds and imported cigarette from about five million to just over half a million, indicating the growth of a very considerable cigarette industry using home leaf. The chief centre of this industry is Guntur in Madras where it has considerable dimensions. A good quality virginia leaf is also obtainable on the light soils of Mysore and of Saharanpur in the United Provinces. At the present time there is widespread experimentation in progress in every tobacco growing district, to see how far this industry can be developed and to examine the possibility of producing the bright yellow golden colour, flavour and burning characteristic associated with good virginia tobacco. The commonest types under cultivation are Adcock and Harrison Special. The cultivation is markedly different to that of ordinary tobacco, in that, whereas the ordinary forms are heavily manured, good virginia must be the product of a rather low state of fertility.

Horticulture. The fruit products

Valuable work on fruit and vegetables either by Horticultural societies or on Government Gardens was in progress long before the Department of Agriculture came into being. When it did so, these gardens came under the control of the Directors of Agriculture and work on the general lines of experimenting with new varieties, selling young trees and training malis was continued. Though people interested in fruit could get assistance by applying to the garden staff, there

was but little systematic experiment and little or no active district work was in progress at any rate till after the Great War, when special Horticultural officers, other than Superintendents of general gardens, began to make their appearance, notably in the Punjab, Bombay and Madras. Of recent years however interest has very rapidly increased and all the bigger Provinces and several of the Indian States have Horticultural Officers engaged in experimentation, nursery production and in aiding and stimulating fruit.

There may be said to be two aspects of fruit and vegetables i. e. the home garden for household use and commercial growing. In comparison with the growing tendency towards increased fruit in the daily diet the supply of fruit at a reasonable price in the bigger cities is poor. Of the 257 million acres of crop only about five millions are under fruit and vegetables.

Fruit, except as may be represented by a tree or two of nimboo, guava or papaya, is not likely to be a common outlet on the average small holder's farm. The scattered character of many holdings and the residence of its owner in the village militate against fruit. So also does under these circumstances the common lack of necessary capital. On the other hand the more commercial or urban market can provide a profitable opening to men of more substantial means and much could be done to improve the commercial value of existing orchards and to ensure that expansion was on sounder

commercial lines, better grown and better protected against fungus disease and insect pest.

Fruit cultivation and indeed every aspect of the problem from the grower to the consumer is very poorly developed as compared with other countries which have given their attention to this outlet earlier. Many of the bigger and older gardens are set out with a mixture of varieties. Specially is this the case in the mango orchards of the United Provinces, which at one time were regarded as private orchards without any intention of sale. The orchards are frequently sold to contractors annually so as to save the trouble of watching. Transport is often bad, packing defective and the condition of storage and care at the disposal centres is lamentable.

One of the more urgent operations of the recently appointed marketing staff was a close scrutiny of the whole organisation and devising of steps to rectify the manner of sale and the conditions reacting against both a fair price to the grower and a reasonable cost to the ultimate consumer.

A large variety of fruits can be grown in the country. The apple, pear, peach and apricot in the hills, in particular on slopes facing northwards; the tight skinned orange, peach and date according to locality in the Punjab; the mango, at its best in the red soils of Madras and Southern Bombay and in the Gangetic valley; guava on almost any of the lighter soils but probably at its best in the east of the United Provinces; the plantain, primarily in Madras and Bombay and the lower Gangetic valley; the loquat in the western districts of the United

Provinces and the lichi in Bihar or other areas of the sub-montane tract where some humidity in the air in the hot season and a high percentage of lime enables this to thrive. The loose skinned orange or Suntra is seen in many places but is at its best in the black soil; the pomegranate, fairly widely distributed but at its best in Kathiawar; the pomelo, its more recent relative, the grape fruit and the lime and papaya in most areas. The only fruit of which there has been any sustained attempt at export is the mango. Of the many varieties (and their name is legion) the Alphonso of Bombay is the best of the widely grown types and incidentally on experiment has proved the best for cold room export. There is also a limited amount of canning of this fruit.

Fruit growing is as yet largely an undeveloped field of work in this country. The Indian public are being educated to its dietary value and the demand is steadily on the increase. The acreage in the Punjab and Bombay is definitely on the up grade.

The Imperial Council of Agricultural Research has of recent years financed a number of investigation schemes on the special fruits of different areas, on the study of cold storage and in experimental working in canning and bottling. Research work is active in variety trials, manuring and other factors affecting production. On the extension side we find strong fruit growers associations springing up in the United Provinces, Bombay and the Punjab, and steady enquiry and progress is being made in the all important feature of better marketing.

CHAPTER III

THE INDIAN FARMER

Factors which detract from efficiency and uniformity of effort; dead and live stock equipment; disabilities under which the majority farm; influences, past and present which contribute; debt; causes and influence; legal steps to reduce; debt but a symptom of a disease; principal causes leading to initial debt; the size and fragmentation of holdings; agencies created to ameliorate actual farming disabilities.

The cultivation throughout India is essentially small holder peasant farming. Landlords or persons functioning in this capacity there exist in plenty in certain parts of the country, for example notably the taluqdars and zamindars of Oudh, the large land owners in the canal colonies of the Punjab, and the mulgugars of the Central Provinces, but it is exceptional to find any of these directly interested in the farming of even a part of his estate as home farm or in what goes on in the villages which he, as in the Central Provinces, controls as responsible for the revenue. For the most part they are content to collect their rents, very frequently as absentee landlords, in particular so when the land, in absence of alienation acts, has passed over to one or other of the non-agricultural castes, the Bania and the like. Where he does exist, as for example as in

the resident mulgurs to be found scattered over the C. P. or when, as occurs here and there in Northern India, he is interested in farming, he can prove and does prove of considerable value in raising the general standard of the farming of the area, where he is located.

Again in most villages there are to be found a certain number of substantial farmers, holding 30-40 acres or more, not as tenants but with established rights to the land they farm. We may class these as yeoman farmers, perhaps more in evidence in parts of the Punjab, the Agra division of the United Provinces and in the Ryatwari tracts of Bombay, Berar and Madras. These are essentially farmers by profession and caste and where they occur may be taken as the village leaders, who, if they can be convinced of the desirability of this or that change in seed or practice, are of considerable importance in any scheme of agricultural progress.

But these between them farm but an infinitesimal portion of the total cultivated land. This rests with an enormous host of petty farmers, the cultivators of India, some as right-holders i. e. possessed of some permanent right to the land they own and for the most part, farm, and others as tenants of either of the classes above or of even other petty land owners; about 50% of this cultivation rests with tenants. It is primarily with these that the production of the crops referred to rests.

Their ability, skill, effort and productive value varies enormously. Certain castes are outstandingly

good farmers, which in India implies that they are hard working and able to extract with such resources as they have the utmost out of the patch, or worse still, patches of land which they farm. Among these we may select the Jat, Sikhs and other Jat communities of the Punjab and Western United Provinces, the Patidars of Gujerat and the Kunbi cultivators of the Central Provinces, Bombay and elsewhere. Other castes on the other hand are indolent or fail to possess that inherent character of being able to make plants grow. There is always a world of difference between the appearance and outturn of land owned or worked by one of the inherently farming castes and that of others who farm because they must live or because they have no alternative.

Again, the standard of his farming is governed by incentive. Where the monsoon is an uncertain factor, the whole level is low; where assured and more so, when protected by irrigation, in particular well irrigation, it is high. Where the incidence of debt is not too enormous and the land is not mortgaged the standard is much better than when practically, except for mere sustenance, all passes to the money lender or the mortgagee. Again, given like climatic and soil conditions, the farming standard of a right holder is usually well above that of the annual tenant. Further, where per chance holdings are more substantial and not unduly fragmented, as for example in the canal colonies of the Punjab as compared with the Central Punjab or parts of Bombay, the general higher level of well-being in evidence in the farming is to be clearly seen. Finally

the influence of climate plays no small part in the effect it has on the health and vitality of the farmer and hence his energy and the manner in which he applies his capital goods. These to a greater or lesser extent have their influence all over the country, explaining higher levels in one tract as compared with another and on the effect and results showing within the individual village even among men of the same caste.

The farmer's working outfit

The farming of a holding, whether big or small,

demands the existence of
 Live stock. certain capital assets, live and dead. The Indian farmer's power is provided usually by a pair of bullocks, several, if he is a big man. The essential number is governed by the character of the farming necessitated by his soil or crop. It is also influenced by whether he has a good well or is a dry farmer only. Over the black cotton soils and in the cultivation of kharif crops a good pair will command 30 or 40 acres of cultivation. In Kathiawar the writer has come across farms of 200 acres most effectively managed by five good pairs. In the alluvial soils where cane, wheat and the like figure in the rotation 8 to 12 acres is all that can be effectively tilled on a single pair. As the vast majority have much less land, one pair, even at times a hired pair, is all that is required. In addition to his bullocks, it is usual to find him in possession of a cow or buffalo. In some areas, as in the Gangetic valley and parts of the Punjab, it is the former. In others, as in Western India, it is the latter. Usually

the animal is kept for home supplies. In some areas like Gujerat the buffalo plays an enormous part in the whole farming economy of the tract. Every Patidar has at least two. Some of his cropping is governed by his buffaloes, and the day-to-day needs of the family are met from their sale proceeds. Unless one has lived in rural India it is difficult to realise how much of the peasant life is dependent on his cattle. Without these, as Darling expresses it in his book 'The Punjab Peasant in Prosperity and Debt' "his fields remain unploughed, store and bin stand empty and food and drink lose their savour". In a vegetarian country milk and ghi, even a little, are a necessity and in the absence of his live stock he would be hard pressed even to cook his food. The loss from time to time of these either from famine or epidemic is indeed one of the primary causes of chronic indebtedness. A pair may cost anything from Rs. 80 to Rs. 300.

The indigenous implements of tillage are rudimentary and though they can be improved on, as will be dealt with later, they are simple in pattern and under conditions where labour saving plays no very great part and man has plenty of time to till the little he has they are for the most part sufficiently efficient and produce in time the tilth his crop requires. The Indian farmer for the most part is a small man, further his farm is more often than not very fragmented. The class of implements he requires and which he has contrived must in consequence be general purpose tools. If a man farms a large area

he can afford to own a series of specialist implements, so as to secure what he requires, as each individual implement will be given enough to do in a year to make it pay its way. A western implement may do a special piece of work more effectively and more cheaply than anything the Indian farmer has, but it is a useless extravagance on a farm of four to five acres, still more so if fragmented. The indigenous implements to be found in one tract relative to another, though created on much the same principles, vary considerably in detail, being modified to suit local requirements, so that though, for example, the indigenous plough to the casual eye may appear as a wedge shaped block of wood fitted with an iron point and connected by a beam to the yoke, differing only in size and weight, this is far from being actually the case and a farmer will be able to provide very firm reasons why the differences noted in detail are important in his tract. Again the stock and variety of indigenous implements kept varies a good deal. It is probably highest in Gujerat and the lowest in the Gangetic alluvium. The plough as mentioned above, which may be described as a single tyne grubber, is universal, varying primarily in weight from the very light implement employed by the Bengali farmer and his microspic bullocks to scratch 2" to 3" deep to implements weighing one hundred or more pounds, calling for four to six pairs of bullocks, as at one time used by the farmer of the Deccan, to give a periodic ploughing in the hot season to depths of 10" to 12". This last is, it may be noted, a specialist implement required for a special class of work

and this accounts to some extent for the marked extension of the use of the heavier grades of inversion (western) plough over this area as effecting the same results at less than half the cost in bullocks and labour. In general however the Indian plough, varying in size to the capacity of the bullock, is a one pair implement.

Outside the black cotton soils and their near environment the plough with a flat log and at times a wooden rake like harrow are the only implements the cultivator ever uses, unless influenced by agricultural demonstration. With these in the alluvial soils of Northern India he prepares his seed bed. Sowing is usually broad-casted, if in lines it is a matter of hand sowing in the furrows made by the same plough, except in the case of dry soil sowings in the heavier classes of soil where the seed must be deposited in the damp sub-surface soil. In this case the plough is fitted with a tube which drops seed in the furrow just behind the plough point, seed being hand-fed into a wooden bowl at the top of the tube. When weeding is done in this tract it is usually performed by hand, though at times to assist this or open the soil surface the plough may again be requisitioned and passed through the crop.

A general higher standard of equipment prevails in the peninsula in general and over the black soils of the Deccan and Gujerat in particular. Here the plough for day-to-day work is replaced by a wide bladed harrow, which may be described as a knife attached by two wooden or iron vertical tynes to a short block of wood, it in its turn being fitted with a type

of wooden beam by which it is attached to the yoke. These implements do not stir the soil but pare the surface, working to a depth under soft soil conditions of 3" to 4". They vary in weight and width of blade, dependent on whether they are required for dry season or moist season work and for field tillage or seed covering. They cover the field rapidly and, as on the whole for kharif crops on black soils the annual ploughing of land is neither necessary nor economical, while speed is essential, are definitely, in so far as they go, effective, as they combine soil loosening and clod breaking, the latter arising from the fact that the hard clods of earth have to pass beneath the block of wood to which the blade is fitted.

Over most of this tract seed is drilled in regular lines and for this, varying from tract to tract, there are drilling devices sowing two, three or four lines at a time, the seed being fed into a bowl whence two or more tubes radiate, ending in short pointed coulter, attached to the block of wood which forms the body of the implement, thus opening the soil to receive the seed. But these are not essential. The poor man with but a small holding effects his drilling by using his bladed harrow or '*Bakhar*', to which he attaches the base of a pointed bamboo by a rope to one of the two tynes, so that, while he drives his bullocks in straight lines backward and forward, stirring the soil surface, his wife holding the bamboo drops in the seed, line by line, with a spacing equal to the distance between the vertical supports. Indeed on the black soils a

poor man can do his soil preparation and his line sowing if but possessed of one bakhar. In general, holdings and individual fields over the Deccan and Gujerat are bigger and this, together with advantage to the crop and greater ease of subsequent weeding and mulching by bullock power, has probably led to line sowing being a standard practice. Though the crop requires some hand weeding, the great bulk of this and still more so the important creation of a loose mulch of earth, to retain moisture after the rains cease, is done by bullock power. We thus have in this tract, in addition to drills, bullock hoes in the farm equipment. These are in point of fact on exactly the same design as the bladed harrow, but smaller and fitted with shorter blades, being commonly worked in pairs using one pair and two men. Here again though the pattern and principle is the same there are variations in blade width and the like as called for by the age of the crop and the normal width of sowing.

In addition to his bullock implements the farmer has a few hand tools. They vary a good deal in pattern. Hand tools. Among the commonest are the *kodali* (of Northern India) and the *mamule* (of Southern India) usually a steel blade of 15" to 18" length giving a 3" cutting edge and fitted on to a wooden handle, which is used in somewhat similar fashion to the pick-axe, the '*phora*' which fulfils the purposes for which a spade is used in Europe but by which the work is done by the arms, the '*Khurpa*', a common tool for hand-weeding, best described as a chisel shaped

piece of iron fitted in a wooden handle and the sickle by which everything is harvested. These vary greatly in size and shape from province to province. Threshing is at times done by hand beating or, as in Juar, by rolling the crop under a stone roller, but is usually performed by trampling under bullocks feet. The subsequent separation of grain and chaff is effected by letting the wind play on the mixture as it is dropped from a basket held aloft and finished off by the dexterous use of the 'sup' or winnowing scoop.

The expenditure on the farm dead stock is therefore but small. In the Gangetic alluviums on a one pair farm it would be covered by an investment of Rs. 12 to Rs. 15. In the black soils a very full equipment per pair would not cost more than Rs. 20 to Rs. 25.

The cost of upkeep is relatively high but a good deal of this is performed by the village carpenter or smith and is paid for in kind.

With this very simple outfit and a good deal of manual effort the many millions acres of India's land are tilled and the many millions of tons of produce referred to earlier are annually created.

The disabilities under which he farms.

As has been emphasised the vast majority of the cultivators of India are peasant farmers and as such small holders, whether they possess certain rights to the land they farm or are tenants-at-will.

The size of the farm necessary to make it a fair holding will naturally be dependent on productiveness.

Eight acres on a soil irrigated from a well may be large enough in order to meet the rent or revenue and provide for the support of a family, while 30-40 acres in other parts of the country would hardly suffice.

We may examine the difficulties this small holder

has to face in making both the ends meet. Some are the outcome of the conditions, climatic or other, under which cultivation has to be done. Others again are tracable to the survival of older influences which have contributed to creating the manner in which he works his farm, the system he has developed, the fashion in which the land comes to him and the customs by which he is bound. Others again may be attributed to modern influences, increased pressure of population as arising from greater internal security, increased rights to the land he farms, the influence of civil courts and the like.

(a) Under the first of these we may record

- (1) The lack of security of a full harvest as influenced by vagaries of the monsoon, at its worst when alternative water supplies are not available; and by the wholesale incidence from time to time, even annually, of insect pests or fungoid disease.
- (2) The extensive cultivation of poor varieties of crop, either in the matter of their yield, market value or susceptibility to disease.

- (3) The enforced use of ineffective capital goods, in themselves sufficient when each village was largely self-contained and each farm self-sufficing; but a handicap where cultivation is concerned with crops competing in any world trade.
 - (4) Relative low soil fertility enhanced by inadequate manurial return.
 - (5) The losses to which live stock are subjected from epidemic disease and the like and the relative low productive value of the vast majority of the live stock maintained, to some extent the outcome of uncontrolled breeding and to some extent the shortage of food supplies.
- (b) To the second cause we may attribute
- (1) The smallness of the average holding and its universal fragmentation over the village cultivated area.
 - (2) The normally found insanitary condition of village life, to no small extent as arising in the past from the value of close association for mutual protection and the securing of a common water supply, factors which together with the broken character of the farms have tended to the conjection of the rural population in closely packed villages and the lack of any possibility of the farmstead being on the farm.

- (3) The general improvident tendency, developed by the self sufficing character of his farming, which gave him but little use for his surplus harvest in the absence of transport together with the feeling of insecurity of the savings in his possession when he had any.
- (4) The inherent attachment of the peasant to his land and its bearing on the amount of unsecured loan thereby made available.
- (5) The necessities imposed on him by caste and custom in the matter of expenditure on ceremonial occasions.
- (6) The difficulty not of getting loans but of securing a productive loan at a reasonable rate of interest.
- (7) Absence of alternative methods of earning a living or of subsidiary pursuits.

Under the third influence we find factors which, while possibly not primary causes, have certainly contributed to his difficulties. The establishment of British control in India led to the removal of certain marked disabilities, as the old time insecurity of retaining the harvest when jeopardised by internal disorder or uncontrolled revenue demand, the difficulties of transport thus opening the way to the disposal of surplus and the establishment of trade, the recognition of rights of ownership or occupancy and the like which at once converted land from

being a liability to being an appreciating asset. But valuable as they were, they have led, especially with the establishment of civil courts and their hard and fast procedure, to certain developments which have reacted adversely.

- (1) Internal security and the expansion of cultivation following on this have led to an enormous increase in the population, a difference of nearly 100 million in much less than a century, an increase largely incident on the rural areas. There is no doubt that expansion of cultivation on new areas has in part met the needs of this expanding population, but the fact of the increase combined with the laws of inheritance has vastly affected the size of individual holdings and the evil of fragmentation already inherent.
- (2) The greater wealth, made available by the improvement in the disposal of produce and the sounder security offered by land, reacting on a population to a large extent inherently unthrifty and prone to borrowing, at times exposed to serious crop and live stock calamity and inclined at all times to ceremonial extravagance, has led to the marked expansion of the money lenders extortionate loans and wide-spread indebtedness of very largely an unproductive character; while the establishment of the civil courts or more exactly their procedure, a necessity in certain ways, has markedly

assisted the money lender, functioning, as he frequently does, as a usurer of the worst type, in establishing a hold on the mass of the peasant farmers which cannot be but harmful.

- (3) Incidentally these courts have led to a great deal of extravagant litigation, very frequently needless and invariably costly.
- (4) The absorption by the cultivator's banker of the business of the final marketing of the cultivator's crop to the marked disadvantage of the producer.

This indebtedness is very high. Sir Edward MacLagan in 1911 reckoned it at 300 crores. Darling in his book 'The Punjab Peasant' estimates it at 600 crores in 1922-23. Little has been done in the meantime to stem the tide of increasing debt. Though certain years of prosperity have intervened others of later date have been much less so. The certainty is that it is considerably above Darling's figure to-day. Though it is hard to be precise, it is probable that potential indebtedness, with old time debts unpaid, compound interest mounting up and fresh borrowings over a period of fifteen years, is now nearer twice Darling's estimate. Debt was then about 18 times the annual land revenue of British India and in all probability it is 30 times this now.

The sum is large and is made worse by the fact that a very big proportion is unproductive. A very

considerable part, between 30% to 50%, is compound interest, while another considerable item consists of borrowings to meet day-to-day living in time of scarcity. A good deal has been borrowed for extravagant ceremonial expenditure. Possibly less than 5% is for genuine land improvement. Of the total possibly not more than 50% is protected, the balance, lent at high rates of interest, is unprotected by mortgages and is dependent on what Darling terms "The triple chain of caste, custom and character" and the close attachment of the peasant to his land.

The services of the money lender cannot be denied. He alone is in the position to provide the bulk of capital required for current agricultural needs and on recurrence of severe distress he will continue, as in the past, to support the people. The charge against him is that his services cost too much and are accompanied by practices which result in great evil. The system is usurious. The smaller man becomes a bondsman to the money lender and few of the profits which should pass to the cultivator from improvements in agriculture, irrigation and the like actually do so. The Indian peasant for the most part works primarily not for profit but for subsistence. Any profit which might be his passes to his creditor. The effect on incentive is obvious. The amount of actual debt owed to the money lender is naturally greatest with those who have the largest credit. Roughly the debt of a large proprietor is about twice that of the small land owner and occupancy tenant and these in their turn owe rather more than twice that of the

tenant-at-will; but, if the debt is measured in terms of land revenue, the smaller the holder the more is he involved. In the small man's case it may represent thirty times the land revenue, in the bigger man's case possibly not more than three to four times.

Acts of different kinds to protect the tenant against exacting landlords and to attempt to protect the cultivator against the money lender exist in plenty. Thus we have Tenancy Acts in various provinces aiming at the former, the Alienation of Land Acts of the Punjab and other provinces aiming at making it impossible to mortgage land to a non-agriculturist for more than a limited number of years, the Usurious Loan Act and its amendments and the Deccan Agriculturist Relief Act, both more or less futile, and the Land Improvement Loan and Agricultural Loans Act, the last two designed to make loans under certain conditions, but on the whole too hedged round with safeguards to be fully popular, and the creation of Debt Conciliation Boards, as in the Central Provinces, for the adjustment of debt. Finally we have the Co-operative Credit Act and the Co-operative Credit Departments which in spite of failings have done a great deal to reduce borrowing from money lenders, a certain amount to relieve the already indebted and a great deal of more recent years in developing other aspects of co-operation, particularly in the Punjab, where there is to-day an organisation commanding twelve crores of rupees of working capital, boasting 22,500 societies-a membership of over 8,00,000 and directly or indirectly in

some form or other affecting the lives of over three and a half million.

Debt is the result of an individual's inability to meet his requirements from the sources at his command. Certain debts are legitimate such as a temporary accommodation, later repaid, or debts incurred on capital outfit and improvements and thus regarded as productive, but chronic debt can but arise from permanent disequilibrium between income and expenditure. Debt is thus, as has been emphasised in the first bulletin issued by the Reserve Bank, but the symptom of a disease. Mere reconciling debts or even clearing debts will not cure the disease.

The root of the trouble lies in various disabilities recorded earlier, not in one only but in a combination of several of these. Thus co-operative credit, as directed primarily to reducing interest on loans taken for agricultural purposes, by itself cannot effect a cure. Better production as covered under better farming, better crops and better methods, by itself will eventually only increase the money lender's income and so on. Progress can only be achieved by simultaneous and sustained attack on the principal factors inherent in each separate case. Co-operation is an essential, but it must be applied in several ways, better agricultural production, credit, the provision of supplies and the disposal of produce and be linked with better living, covering subsidiary occupations, sanitation and thrift. The leading causes giving rise to initial debt other than social extravagance are (1) the small and above all the fragmented holding;

(2) the absence of crop security, as can be met by the extension of irrigation schemes and more so, in at any rate certain tracts, by the increase in the number of wells or the improvement of existing wells, done on terms which make it easier for the cultivator than those offered on a taccavi loan, which in many cases is out of the range of those who most need such help; (3) loss in live stock as from famine or epidemic.

The problem of the small divided holding and still more of the fragmented holding, whether applied to right holders land or the fragmentation found in many tenants' farms, is fully dealt with in the report of the Royal Commission on Agriculture. The small holding, and it must be realised that many of these are but allotments, is a wide spread difficulty. The average holdings in provinces vary but none are big; Bombay 12, the Punjab 9.2 acres, at the head of the list, Bihar and Orissa, Assam and the United Provinces, at the end of the list, with 3.1, 5 and 2.5 acres respectively.

In the Punjab at the time of the Commission 22.5% of the cultivators had less than 1 acre, 15.9% between 1 and 2.5 acres, 17.9% between 2.5 and 5 acres and 20% under 10 acres. It is virtually impossible for certainly the first three to make income and expenditure balance without subsidiary occupation. Fragmentation of owned and of cultivated land may apply to all classes of holding. It is probably at its worst in the medium and larger holdings. It cuts out economical working, wastes

land and makes improvement in method almost impossible when carried to the extremes in which it is at times found. Thus in one case quoted in the Punjab 34% of the cultivators of a village had each 25 or more separate plots. The most effective efforts to deal with the evil are in force in the Punjab and Central Provinces. In the former consolidation is dealt with co-operatively, in the latter by the Central Provinces Consolidation Act applied to one division in which fragmentation is intense. In both early progress was slow; but once the manifold advantages which follow became obvious, the rate of progress has been rapid. At the present day, in the Punjab, a movement which began 20 years ago has to its credit 7,00,000 acres of consolidated holding, while in the Central Provinces, on an act which came into force just over a decade ago on a very small scale, over 400 villages have been consolidated while hundreds are on the waiting list.

Uniform soil and simplicity of tenure simplify matters in the Punjab. In the Central Provinces a holding can rarely be brought to a single block and to do this would in view of the varying soils and the crops pertaining thereto be undesirable. Consolidation has been rapidly followed by better farming and co-operation. Another method, adopted in the United Provinces to do away with certain of the evils of isolated fragmented fields and tiny patch work cropping, has been the consolidation of cropping i. e. the co-operation of groups of villagers owning contiguous plots in growing the same crop. This is much in evidence in the new State tube-well areas,

where the advent of water has been accompanied by special agricultural and co-operative effort to organise a new system of farming and cropping, as made possible by this water, together with the effective marketing of the main crop—sugar-cane. It is also in evidence in the better farming and better living village societies organised in the east of that province.

We may now turn to the agencies, created by Government, which seek to deal with the chief disabilities in section (a), those associated with agriculture, the insufficiency of water and live stock, the services devoted to crop, live stock, veterinary and irrigation improvement and development.

CHAPTER IV

THE AGRICULTURE DEPARTMENT

Origin and development; the present service; agricultural education, higher and lower; Research; the Indian Central Cotton Committee, the Imperial Council of Agriculture Research; Government Farms and their functions. Seed supply organisation and propaganda; the art of bringing the product of research into general practice; examples of effective propaganda. Some of the fundamental agricultural needs; how they are met; better seed, fertility, implements.

The first reference to the need of a Department of Agriculture in India appears in the recommendation of the Royal Commission appointed after the Bengal famine in 1866, stimulated a few years later by Manchester cotton interests upset by the disturbance of cotton business interests by the American Civil War. Certain activities appeared in Bombay and the Central Provinces chiefly in the nature of the trial of exotic cottons. Otherwise nothing of value resulted.

The next indication of interest followed another famine of 1880-81. As the outcome of this we find the development of embryonic departments,

usually linked with land records, and the establishment of experimental farms in all the major provinces, of which those of Bombay, the United Provinces and the Central Provinces may be deemed to have been the more effective.

This period which lasts from 1880 to 1905 includes the visit in 1889 to 1891 of Dr. Voelkher whose book 'The Improvement of Indian Agriculture,' though written 40 years ago, is still of utmost value to students of Indian agriculture. The period is associated with the appointment of the first research workers like Dr. Leather as Agricultural Chemist and Dr. Barber in Madras as Economic Botanist and includes the early beginnings of agricultural education at Poona, Cawnpore, Nagpur and elsewhere whence at a later date the present agricultural colleges developed. It cannot be said that achievement was large, but it attracted attention to the need of applying scientific investigation to the problems of agricultural improvement and provided a vast amount of data of value later.

It however required another famine and another Commission, that of 1900-01, to cause the creation of the Department as one finds it to-day.

The genesis of the present department.

The recommendations of this Commission were rapidly put into effect by Lord Curzon's Government. The commission of 1880 laid down the collection and study of vital economic and agricultural facts. The commission of 1901 emphasised the need for

scientific research and the development of an organisation which would bring what was of value into agricultural practice.

The department as we know it to-day, though may be enlarged in its scope and aided by greater research facilities of later origin, came into being in 1905.

It consisted of an Imperial Research Institute at Pusa where the then scattered scientists of the Imperial Agricultural department were centred and provincial services, each consisting of a full time Director (at that time a member of the Civil Service) supported by certain head-quarter research staff, an expert agriculturist, chemist, botanist, entomologist and mycologist, engaged in agricultural research and higher agricultural education, and by other agricultural experts in the more important tracts of each province, engaged in field experiment and in propaganda so as to link up the first group with village agriculture.

To a greater or lesser extent the above organisation was established and substantial advance was in progress when with the outbreak of the last war many officers were permitted to serve in the army leaving a skeleton force which with the greatest difficulty, kept the department running.

In 1920, the service was again restaffed and since that date there has been a steady expansion which has varied with provincial resources and interest. Following on the above and as the

Final establishment
and later development.

outcome of the Government of India Act 1919 the department became a transferred subject under a minister-in-charge responsible to the local legislative council for funds. At the first onset of the change there was an almost universal tendency to curtail departmental budgets and all budgets sagged heavily from the 1920-21 level. Subsequently however the value in most provinces was recognised and the funds provided rose steadily till the general slump of 1931-32 called for retrenchment in every direction, a temporary condition of affairs which with the rising value of agricultural produce and the greater interest in rural development at the present day has been more than made good.

In 1924 further overseas recruitment ceased and thence forward with greater or lesser celerity the different provinces have organised their respective first and second class provincial services. In 1923 the Indian Central Cotton Committee, to be referred to later, came into being and in 1930, based on the recommendation of the Royal Commission on Agriculture in India, the Government of India founded and financed the Imperial Council of Agricultural Research. Both these bodies, the former in respect of cotton, and the latter in respect of other crops and live stock have been instrumental in developing and financing research (and in the case of the former extension) work conducted under the administration of the Directors of Agriculture in all provinces and certain major States. This has very materially contributed to the staff employed and funds made available for research work of all kinds, a great deal of which

could not have been attempted by the departments of the provinces concerned on the budgets at their disposal and has enabled increases in provincial budgets to be devoted to the all important operation of extension and propaganda. The Agricultural department proper, exclusive of the special temporary officers engaged in handling schemes financed by these bodies, numbers at the present day 307 Gazetted Officers (I and II class provincial services) and 1,735 non-gazetted (District Inspectors and qualified subordinate staff other than fieldmen).

The construction of the service to-day is on the whole that laid down in 1905.

The Agricultural Service. It consists of the Imperial

Agricultural Service financed by the Government of India and services maintained in each province. The first named is head-quartered at Delhi, transferred thither after the Bihar earthquake had destroyed Pusa in 1933.

It is essentially engaged in research problems associated with crops and live stock. In addition to the central laboratories and farm at Delhi it includes a plant breeding station at Karnal, the sugarcane breeding station at Coimbatore, the Institute of Animal Husbandry and Dairying at Bangalore and the Imperial cattle breeding farm at Karnal. This is administered by the Director of the Imperial Agricultural Institute at Delhi supported by the heads of the various research departments.

The provincial services are again much on the lines of the past but with certain additional expert

departments. The size and scope varies somewhat from province to province.

The usually found divisions are research and education, agricultural extension and propaganda, live stock breeding, agricultural engineering, horticulture and marketing.

The staff under a Director is the provincial gazetted staff, comprising officers of class I and class II provincial service, the upper subordinate staff, invariably graduate assistants, filling posts in the research laboratories, the college and as in charge of farm and district activities and the lower subordinate, non-graduate staff, chiefly employed in extension and propaganda in the district.

The Director, at times in the larger provinces assisted by a Senior Deputy Director as Assistant Director, is responsible for the entire administration and the fulfilment of the policy laid down by the Government.

The research and higher agricultural educational staff, in a typical instance, would consist of an agricultural chemist, two or more economic botanists, a plant pathologist, an entomologist, and an agricultural expert, officers of class I, supported in most cases by assistant officers of class II. The Principal of the Agricultural college is usually the senior-most of the above. They are stationed for the most part at the head-quarter of agricultural activity which does not necessarily coincide with the headquarters of the Director.

These officers are responsible for research and education in their respective spheres, the last being correlated and controlled by the Principal.

The propaganda and extension staff consists of three, four or more Deputy Directors according to the size of the department. Each controls a circle which is usually subdivided to two or three lesser divisions under the charge of Assistant Deputy Directors or Divisional Superintendents, officers of class II. These officers are responsible for the field examination of the products of research work, the testing of agricultural implements and the like on their experimental farms and the isolation of what appears to be of economic value, for the multiplication of seed and its effective distribution and for demonstration and extension work in general. They are assisted by a considerable staff at work on their farms or in the districts and provided from the upper and lower subordinate cadres.

Most provinces have in addition to these two main groups: a Deputy Director in charge of cattle breeding farms and live stock improvement, an agricultural engineer, aided in the provinces where more attention is given to this, by assistant engineers (class II) whose functions are the improvement of under-ground water supplies, introduction and charge of agricultural machinery, tractor activities, if any, and the invention or modification of agricultural implements to suit local needs, a horticulturist and his staff engaged in fruit development, a comparatively recent addition, and a marketing officer.

The amount of attention given to these various activities and the staff made available in each section depends on provincial interest, provincial resources and the openings calling for special attention to this or that line of development.

The highest form of such education is provided at the Imperial Agricultural Institute, Delhi. This appears in the form of post-graduate courses, of about two years duration, in agriculture or in one or other cognate sciences in which research is in progress. The standard for admission is the M. Sc. of an Indian University or a first division pass from a Provincial Agricultural College.

Below this come the Agricultural Colleges of India of which there are five directly associated with the departments of agriculture of Bombay (Poona), Madras (Coimbatore), the Punjab (Lyallpur), the Central Provinces (Nagpur) and the United Provinces (Cawnpore). They were all started as departmentally controlled colleges giving a Licentiate in Agriculture but are now, joining in the above order, affiliated to local Universities and in so far as studies and examinations are concerned are controlled by these bodies. The courses are from three to four years, depending on whether admission can be secured after passing the Matriculation or at a later date in University studies. In addition to the above Government Colleges, conferring degrees equivalent to the B. A. or B. Sc., there is one degree course obtainable from Allahabad University where

agriculture and part of the cognate sciences of the course are in part provided for by the Naini Institute, a missionary organisation which has specialised in agriculture.

The actual selection of educationally qualified applicants for admission in most colleges is governed to no small degree by their landed interests and the scope they offer for the later application of what may be learnt. The courses given aim at a general firm grounding in the theoretical and practical aspect of agriculture and its cognate sciences. The general standard of the subject matter and instruction in these courses compares favourably with what is provided in other countries and though the standard of a bare pass in the third division is not high, a student passing out in the first division or top of the second division may be said to have acquired a sound appreciation of what is implied by scientific agriculture and, in particular if he comes from an agricultural caste, is likely to make a first class agricultural officer.

In the early days it was difficult to fill these colleges and the standard of education of recruits was low but at the present day the standard is better and applicants far exceed the number of seats.

Though a very fair percentage of such students are at the present day to be found farming, the majority, as is the case all over the world, take a course of this kind with the hope of employment, either in the department or elsewhere. The upper subordinate service whether employed in the research sections or in the field service is all recruited from this source.

There are three alternatives which have found favour in different provinces.

Agricultural education (vernacular).

(1) Vocational training, as applied after the student has completed his vernacular or Anglo-vernacular education, directed to agriculture and a few subsidiary and allied subjects, a one to two years course at a special centre.

(2) Pre-vocational training in which agriculture is taught in the middle or anglo-vernacular school courses at what are termed Agricultural Bias Schools.

(3) Short courses in special subjects, primarily of a practical character, conducted at Government farms.

The object of the first was to give the son of a land owner and farmer an alternative to the ordinary high school course to which he did not aspire and to equip him better for the running of his property. They found some favour in Bombay when there were at one time six, now reduced to two. They also exist in the United Provinces, where there are two such schools giving quite a good standard two years' course to the sons of zamindars. The majority of the youths so trained do return to their own lands, though they are also willing enough to take a post in the lower subordinate service, specially since the slump in agricultural prices.

The second type is very prominent in the Punjab and has been adopted in Bengal and in the U.P. In these a certain amount of time is made available in

the ordinary middle school time-table of a rural school to admit of theoretical and practical training in nature study and agriculture. The school according to strength and location is provided with either a small farm or a garden plot and a qualified teacher, who manages the little farm and controls the boys in their work thereon. The farm, if in an irrigated tract, is of about six acres in area, sufficient to permit the maintenance of a pair of bullocks, while a garden plot covers about an acre, any necessary heavy work requiring bullocks being done by hired animals. In dry tracts like the Central Provinces, farms would have to be larger and would not provide the continued facility for work available on irrigated areas. Where water is limited the garden plot type is better. Many of these school farms and plots, specially in irrigated tracts, do quite well. They are at their best when the school is not entirely dependent on day boys. Success is dependent on the interest of the head-master and on the careful selection and training of the teacher. If well run they can provide very useful propaganda centres. This class of bias school is intended to prevent education divorcing the boy from his surroundings.

The last type of education is essentially short course and practical and is held at a Government farm, at a rural Institute or even at a college. Common examples are oil engine and tractor classes, dairy classes, fruit canning and bottling, intensive modern agricultural short courses, poultry classes and many others. They last from three to six weeks and are open to men of any grade from the small holder to the employee of a bigger man.

Of these three classes Nos. 1 and 3 are worked by the Agricultural Department while No. 2 is a function of the Educational Department with possibly a little Agricultural Department inspection and guidance on the farm.

In the years which have passed since the department was created a very large amount of useful scientific investigation has been done, bearing on all factors which lead to a better understanding of the soil on which the crop grows, the improvement of the plants in yield, quality and the like and the best means of defence against the insect pests and diseases which take a heavy toll each year on what Nature and man could otherwise provide.

This knowledge and this material have been contributed by the permanent workers at the Imperial Agricultural Institute and the other provincial centres.

Some of this work has been fundamental and a great deal has been the application of the fundamental to practical problems. The outcome of this work is to be found in the publications of the Imperial Department and in the many bulletins issued by provincial centres, but above all it is to be found in the actual practices advocated by the department and steadily becoming local acceptances, in the numerous improved strains made available in every important crop and represented by a substantial area now under these improved types and in the methods now applied to the control or

check of at any rate some of the principal agents tending to inhibit a full harvest.

Judged at any rate by the number of economic botanists and plant breeders directly employed by Government, the greatest amount of attention has been devoted to direct plant improvement, whether by selection from existing forms or by hybridization, as the easiest method of helping the cultivator. A good seed from an improved strain, whether it be for higher yield, better quality or greater resistance to this or that inhibiting factor, need cost him but little either in the matter of cash outlay, of which he has little, or in calling for any impossible change in the way he grows it. It is on this account that the largest number of evident improvements and the very obvious utilization of these in practice are much in evidence as the outcome of the work of the officers engaged in this branch of research.

Among the most evident we may record the Pusa wheats which cover large tracts of the Gangetic alluvium, the wheat evolved by the Punjab for their specific needs, the sugarcanes of the present day, created at Coimbatore, which occupy 85% of the area under this crop, many of the paddies to be found in common cultivation and at any rate certain of the important cottons in general use.

These and many others and no small modicum of our knowledge in other directions must be credited to what we may term the permanent staff and the normal budget resources of the Imperial and Provincial departments of Agriculture. The chief

weakness has been the comparative water-tight compartments in which each department conducted its efforts.

There are however two external agencies which have contributed very considerably of recent years to the cause of agricultural research by direction and by the provision of financial help. Without these it would have been impossible for the Imperial Department and still more so the Provincial ones to have made much of the more recent progress now becoming obvious.

The first of these is the Indian Central Cotton Committee and the second the Imperial Council of Agricultural Research, both of which play a very prominent part in the advancement made in this section of departmental enterprise, the former in cotton matters only, the latter in all directions of agricultural research and live stock improvement. Their origin, constitution and the part they play are best dealt with here.

In 1920-21 the Government of India Act came into operation. On this agri-

The Indian Central
Cotton Committee. culture became a transferred subject. It was felt by many at

that date that, when entirely controlled by the local legislature, agriculture might run some risk of financial starvation, a fear that was intensified by the somewhat marked curtailment on agriculture in all provincial budgets. Further, as the advantage of research work is not immediately apparent, that such legislatures, pressed for money for more immediately obvious indications of their local value,

even though willing to find funds for propaganda and field works, might be definitely chary of financing all important research. The above stimulated by the findings of the Cotton Commission of 1920 on the need for greater correlation of research work in this crop and more intensive efforts on the improvement of what was then grown, led in 1923 to the formation of this committee consisting of representatives of the cotton trade, the cotton grower and Government agricultural interest, financed by a cess of two annas per bale levied on all baled cottons. This body has worked with marked success in many ways to improve the Indian cotton industry and, though all this has not been directly associated with actual cotton improvement, the majority of its expenditure has been devoted to the financing of research schemes, directed to the production of better types, and the combating of causes reacting against plant yield or to extension schemes aiming at putting the outcome of research into general practice. Its efforts have very largely contributed to the existence of the 5 million acres to be found under better cottons to-day.

It has an annual income of about 8½ lakhs and on this together with reserves, created in its earlier years, it maintains an excellent technological laboratory in Bombay of use both to the trade and the research worker, a large share of the Institute of Plant Industry at Indore, some twenty one separate research schemes and sixteen seed distribution and extension schemes in operation in the principal growing tracts. In the former in many cases local Govern-

ments find the land and permanent buildings only. In the second the expenditure is provided to increase the personnel and supplies which local Governments may already provide.

This body owes its origin to the Royal Commission on Agriculture of 1926.

The Imperial Council of Agricultural Research. In the course of its investigation the Commission drew attention to the lack of cohesion in the

matter of research between the Imperial Agricultural Institute and the provincial centres and between these in one province and another. To remedy this they suggested the creation of an Imperial Council of Agricultural Research, the primary functions of which would be to promote, guide and co-ordinate agriculture, including veterinary, research and to link this with like work in other parts of the Empire.

In due course this suggestion with certain modifications was accepted by the Government of India and the Council, assisted by an advisory board of purely technical character, financed by a lump sum grant of 25 lakhs and a provision of 7½ lakhs annually of which 5 lakhs was for the promotion of research, came into being in 1930.

The Council finances schemes of all kinds bearing on soil, crop and live stock interests. These may be divided into certain groups.

(1) Special all India schemes which call for a special central, but not necessarily permanent organisation, e. g. sugar technology and locust research, agricultural marketing and the statistical aspect of field experiment and animal husbandry.

(2) Schemes calling for the temporary expansion of the central research Institute e.g. sub-stations of the Imperial Institute at Karnal for plant breeding and plant botany.

(3) Co-ordinated schemes of research carried out in several provinces where grants are given to extend local facilities e. g. the rice research schemes in Madras, Bengal, United Provinces, Central Provinces and other Provinces; the sugar-cane testing stations in several Provinces, Fruit research and dry farming research existing in several tracts.

(4) Research schemes carried out by arrangement in one province or State on a problem of all India importance e. g. the Bombay fruit storage scheme and the many of more fundamental character financed at universities throughout India.

The more important subjects are usually first dealt with by sub-committees. Thus sugar, wheat, fruit, animal nutrition and others have each special sub-committees. Any new schemes are first examined by these, thence they pass to the Advisory Board, where they are accepted, amended or rejected. Those which receive the Board's approval are in due course dealt with by the Council with whom finance rests.

In allotting funds for schemes under (2) and in considering schemes under (3) and (4) attention is given to the suitability of the tract or place where the work is to be done, the general all India or at least wide area significance of the proposal and the facilities or financial contribution offered by the province, State or private body from which the scheme

comes. Schemes of purely local application are never considered, unless they fit into one of the chain schemes as under (2).

The Council funds unlike those of the Cotton Committee have hitherto not been used for extension, which has been considered to be a function of Provincial Department, though with an anticipated increase in its resources it is probable that greater attention will be given to such work.

The vast majority of the schemes in progress have been reported on by Sir John Russel in his recent report on the work of the Imperial Council as fully satisfactory and with every indication of providing useful results. The organisation thus created has done much to remove the individuality of effort in evidence in the past, to weave agricultural research workers into one closely associated and co-operating body and to put the whole level of work on a much higher plane.

These may be	classified as research, experi-
Government farms.	mental, seed and demonstra-
	tion and model.

The types in practice tend to overlap a little in their functions. The first are essentially those where original research—plant breeding and the like—are the chief interests, the main head-quarters farm is essentially a research farm and this may apply to other farms controlled by specialist officers. The second and indeed all the remainder are in charge of Deputy Directors and are located in different parts of the province, usually near the head-quarters of one of these officers. Their functions are threefold:

(a) the exact conduction of crop trials and other field experiments likely to lead to applied results—the closer examination of the products of research under local conditions, (b) the systematic testing of new implements or machines, (c) the production of nuclei of improved seed under a condition of complete purity.

The name 'Seed and demonstration farms' is sometimes misleading, in that people are led to expect them to be demonstrations of how to run a farm. In point of fact their primary object is the multiplication of seed suited to a given tract, possibly accompanied by a certain amount of local field trials and the provision of object lessons in the utility of a certain implement and an improved method of growing a crop on a field scale. A great number of such farms pay their running expenses; but when it is realised that their buildings are invariably put up by the Public Works Department and are costly for farming and that they must grow the crops which are required for local seed and not of necessity the more paying crops, the expectation of their being examples of economic farms as businesses is small. The last type is rare; certain however exist in the U. P. They are usually small farms largely cropped for profit with cheap buildings and may be said to be the nearest approach of Government farming as set forth to illustrate what can be secured under modern conditions. The experimental and the seed and demonstration farms carry the products of research one step nearer the village. They weigh up the economic utility of the suggestions and products of research,

isolate the implements, crop treatments, manures and the like which may be useful and create the initial stocks of better seed.

Research and the experimental farm, as it were, provide the goods which are to fill the shop window. These
 Propaganda, seed supply and extension. provided, the dressing of the shop window must follow. In short the goods in the godown must reach the consumer and they must satisfy him as to their value. This last is what is aimed in this phase of departmental activity. The two chief functions of a Deputy Director outside the farms are the establishment of a sound seed supply and distribution organisation and the best means to get this seed or any other improvement absorbed as local village practice. Both these are extremely important, otherwise earlier work is well nigh useless. Neither are easy.

We have seen that an experimental farm is used to compare a certain
 Seed supply. number of types of a particular crop as received from the plant-breeder. As the outcome of this we will assume that two or three are promising. These are usually further tried out experimentally at the different seed and demonstration farms under departmental control where soil and climatic conditions may vary appreciably from that of the experimental farm. Here perhaps one or even two of the promising types may drop out as unsuited to this or that local condition. This provides certain fairly reliable data placing variety A as superior under one condition and

B under another over the local type. Crop varieties however are influenced by the field conditions under which they are grown. Thus a variety of sugar cane which may do well under high farming may cut a very different figure under poor management. To some extent this is safe-guarded by conducting trials under manured and unmanured conditions; but the best information is secured by conducting simple trials against the local type on the farm of a responsible farmer or by financing small privately managed experimental or testing farms under departmental supervision. With this combined data behind him the officer has information of dependable type on which he is able to state with certainty that he has a variety which under certain conditions is better than those already in cultivation. Once this is assured, then the multiplication of the seed must be taken up. A certain area of the Government farm or farms is allotted. On this the seed is grown, rogued of any impurities, and a certain nucleus is created; but the seed which can be grown on a Government farm, even a big farm and many are quite small, is limited. Its issue, leaving further expansion solely to natural spread, will lead nowhere or at best in two or three years to a degenerated and mixed crop, posing as the variety. India being farmed primarily by small holders, it becomes all the more essential to create an organisation which will maintain a steady flow of seed always originating at the source viz. the Government farm. It is only by this means that a sufficient quantity of good seed can be made available and that quality can be maintained.

The method of multiplication varies a good deal. In the case of cotton, the seed grown and ginned on the farm is placed next season with certain substantial growers of repute, termed A grade registered seed growers. Here it is again rogued by the departmental staff and ginned at a public ginnery but under supervision. The seed is then issued to groups of growers or unions, members of a co-operative sale society, grown by them, if possible rogued, and again ginned at one centre, providing the bulk seed which is sold off to ordinary growers. The process continues from year to year and there is thus a steady flow along a regular channel providing effective quality and quantity for full sowing. In the case of wheat in the Central Provinces the spread of a good variety is assisted by the fact that there is an appreciable number of resident mulgari land-lords who can be supplied at regular intervals with pure seed from the Government farms, which they grow on their home farms. It is also advantaged by the fact that the cultivators of the villages sell off their wheat and come in each year to get their seed supply on sawai (repayment at harvest of seed given plus an addition of 25%) from the land-lord. As his supply is the approved wheat from the Government farm, it does not take long for a whole village to be under one wheat. In the Punjab reliance is placed on big departmental seed farms, building up a big nucleus, supported by the fact that in the canal colonies there are a number of large estates, which, taking on their seed from the Government farms are in a position to supply this in good quality in bulk. The organisation

there is thus largely a matter of finance and transport, the department buying up these stocks, transporting and reselling in smaller amounts to the peasant farmer either direct or through co-operative societies.

In the United Provinces we find a more difficult position, as the land-lord does not, as in the Central Provinces, deal in seed and big growers, able and willing to carry over seed from harvest to sowing and still more so willing to lend it on sawai to their tenants, are but few. In this case the multiplication of seed and its supply is secured by issue of farm seed on sawai or cash to registered seed growers, owners of fairly large areas. Their seed stock is purchased for storage in Government seed depots, followed by its issue the following season on sawai to smaller men, if possible another ring of growers, whose seed is largely purchased back and issued to the small grower the following season for ordinary commercial sowings. Government in the United Provinces maintain about 400 seed depots, handling four to five lakh maunds of seed each year.

Propaganda takes several forms. It may take the form of the time-to-time visit of an Agricultural Inspector, usually giving his attention to the farming of one or two of the bigger men with the hope that by inducing them to adopt this or that, there will be some emulation among those about him. It may take the form of collecting villagers and introducing them to the work of a neighbouring Government farm.

Again, the annual fairs and exhibitions to which the cultivators throng provide openings for an agricultural department exhibit coupled with the demonstration of certain implements, the show put up by the department varying with the importance of the occasion. It is true that these occasions attract large crowds and it is possible that at times an idea is accepted or an implement is introduced; but on the whole it is doubtful whether any of these means have much lasting effect. Possibly at times in an area where the department has been active and a certain amount of advance has been attained, leading to the existence of several growers of improved crops, several users of improved ploughs and the like, the organisation of a local show, carrying prizes for good samples of improved crops or for ploughing contests and so on, does stir up local interest and bring forcibly to the notice of other farmers what certain farmers within their area are growing and using.

But at the bottom of things the only effective way to get a new variety or method or a new idea taken up is to demonstrate this in the village and on the villagers land. The average cultivator has little or no faith in the applicability to his conditions of what he may see on a Government farm; indeed very often the mere fact that his landlord does this or that on his home farm does not impress him. For the most part he is uninfluenced by the written word, as he cannot read, and he puts but little faith in what he is told, unless by some means as by a successful result he has seen, the teller has already

secured his confidence. After all this is not unreasonable. It must be realised that he is a small man, and small men cannot afford to experiment or speculate. He is therefore likely to be influenced by what he sees is effective on his own land or on his neighbours under conditions like his own.

He is more likely to take up an innovation which may possibly call for a little more effort but which does not demand cash. On the other hand, if he is convinced that what is offered is effective, he will rapidly adopt it, even if it does imply some expenditure, provided he has the money or can get credit.

Demonstration work cannot be fruitful, if it is spasmodic. The occasional or irregular visit of an agricultural officer to a village seldom produces lasting results. To establish a new variety and still more a new practice calls for frequent visits, calls for personality in the officer and calls for recognition by the leaders of agricultural thought of the officer as a friend and not as a chance visitor.

One of the difficulties of effective propaganda lies in the difficulty of making contact with dozens of men, none of them big and of maintaining that contact.

In the writer's opinion there are but two methods of systematic effective approach, the intensive and extensive. In the former no attempt is made to cover a whole tract; certain special blocks of villages are taken in hand. A block consists of eighteen to twentyfour

Intensive propa-
ganda. The village
units.

villages. This block is in charge of a lower subordinate officer assisted by three fieldmen, one for each sub group of six to eight villages. In each village an attempt is made, helped if there is a credit society, to create a Better Farmers Society or Farmers Club from among the leaders and better farmers of the village. Any one is enrolled provided he is a keen farmer in the eyes of the village and is willing to conform to its very simple requirements. The goods for the shop window are then examined. A selection is made by the Dy. Director of certain new types or methods which deserve pushing and are reasonably certain to give results. Arrangements are then made in a meeting of the society for three individual farmers on whom they can rely to undertake to test, for example, a certain new type of seed, on a plot of quarter acre or some such size on their holdings as against an equal area of the village variety. Three, four or more of these demonstrations are allotted, with always three representatives for each species of demonstration. They are then taken up as the time for their handling arises; the seed, if it is a case of a new type, or the implement or the manure or whatever it is, being arranged for by the fieldman who is in continuous and weekly touch with the members of the club and assists at any critical point required of the novelty. Every opportunity is taken by the circle-in-charge and senior officer when visiting the units to get members to take an interest in what is going on. At harvest plots are cut, weighed up and the merits of the new with the old are discussed as a club matter.

There is no added cash cost to any grower who undertakes an experiment. A new seed is given in exchange for an equal quantity of the seed he would have sown. If a new implement is on trial it is lent. If it is a question of the use of cake or a fertilizer, this is supplied free on the trial plots. Finally, as confidence is everything, there is a guarantee, that, if on the average the yield from the new is not at least equal to that from the old, the difference, if it occurs, usually but trifling, will be compensated. Following on the success of a new variety of wheat or paddy and the like there is not very much difficulty in getting one or two men to become the seed farmers of this type for the village, on the basis of exchange of their seed for an equal quantity of the improved, thus providing, at least, all the members with seed of the improved type for the following year's sowings.

The writer has come across several striking waves of wholesale acceptance of new strains of paddy, sugar-cane and wheat, efforts to increase home supplies of manure, a demand for a new implement and the almost wholesale acceptance of a standard manurial dressing or protective crop treatment as the outcome of this concentrated type of village propaganda.

This again is a form of bringing improvements into a village and of getting the cultivator to realise that there is a department. It may be safely said that there are millions who do not even at this day know of its

Extensive propa-
ganda. The itinerant
cart.

existence or, if they do, it is only as something outside their horizon.

The equipment consists of specially designed carts fitted with a lantern, gramophone, selected lectures, seed and other samples, charts, implements suited to the tract, literature of a very simple character, small packets of vegetable seed, sulphur, ammonium sulphate and the like for selective free distribution. The outfit includes a pair of bullocks and an effective ploughman and an assistant in charge. Such carts proceed on definite circuits, notified in advance with the help of the Revenue authorities, visiting key villages at intervals of eight miles and halting there for a couple of days, during which agricultural matters are discussed, farmers' fields visited, and lantern and other short lectures and demonstration of implements given. This visit of the cart may be followed up by another later or by an assistant to see that implements originally ordered are being properly adjusted and that seed orders have been fulfilled. Such itinerant carts are in operation for about seven to eight months and cover about twelve to thirteen villages per month. The method cannot be said to have the full effect of the first, but, as a halt at one village means that a respectable number from perhaps two to three villages in the neighbourhood come in, they have a fairly wide influence and they fulfil at any rate one of the essentials viz. of bringing the goods of the shop windows to the doors of the cultivator.

It is possibly not easy in dealing with a country of varying climate, soil and conditions to narrate in a few pages the chief farming handicaps on arable farms as we find them, the steps taken to lessen these, the methods offered as remedies and the obstacles which may react against rapid application. The fundamentals are (1) the provisions of dependable water supplies which will be dealt with separately under irrigation, (2) better seed, (3) steps to increase fertility, (4) better implements, (5) alterations in methods of growing the crops, (6) more productive live stock, and (7) improved market facilities.

In this section only numbers 2, 3, 4 and 5 will be touched on as these pertain to what has been dealt with viz. agricultural demonstrations. Nos. 6 and 7 will be better considered when the efforts of other sections of the department in the general scheme of improvement are being examined.

We have to some extent dealt with the question of better seed. Improved crops are dependent on the introduction of strains which increase yield, improve quality or provide a plant which in some way or other resists a common defect which, if unprevented, reacts on yield or quality of the type in common cultivation. In the very earliest stages plant improvement was almost entirely confined to attempts to meet this by the introduction of exotics. For the most part there were failures; but the influence of this procedure can

be seen in certain tracts. It was applied: primarily in cotton, sugar-cane, tobacco and ground-nut and, though it would be incorrect to say that the cotton growing in certain tracts is always the unchanged lineal descendant of such efforts, the Cambodia cotton and Dharwar American cottons are instances of wide spread types which owe their origin to this procedure. The same applies to sugar-cane and to some of the fairly wide spread older types of ground-nut still in common cultivation. In so far as tobacco is concerned, though little or none of the earlier types introduced are of importance, practically all the present day improvement in cigarette leaf cultivation is associated with relatively recently introduced exotics like Adock and Harrison special.

With the establishment of the present department the direction of improvement turned to the examination and selection of indigenous varieties and the further plant to plant selection within those forms which possessed the general characteristics of the variety or type to the highest degree. The Pusa wheats Nos. 4 and 12 which to-day occupy large areas in the Gangetic valley are direct selections from the mixed population of field wheat. Many of the pad-dies in extended cultivation as improved types, not a little of our improved cotton, linseed and grams owe their origin to this procedure. It entails the cultivation and examination of the progeny of hundreds of individual plants, varying often slightly in the particular factors sought and in which the local form is deficient, and the fixation of these. Such selection is limited in what it is likely to provide.

A selection may give a higher yield but on the other hand the quality of the produce may be low or it may be particularly susceptible to some fungoid disease. It may possess certain characters which render it desirable and others which detract from its utility. But it is possible to combine the characters from two different parents, so, as it were, to create a plant of good yield and better quality or at any rate possessed of a larger collection of better characters. This is effected by hybridization and subsequent plant to plant selection within the products of the cross, and though straight selection does still play a part in the general efforts of the crop breeders at work all over India, hybridization dominates in the building up of the perfect form. The most striking example of this is to be found in the modern Coimbatore canes. By this hundreds of new types are created and after testing there and at the chain of sugar-cane farms throughout India, pass out to provide the new forms which suit this or that province, soil or cultural condition. Hence has arisen the rapid replacement of the old indigenous canes, specially in Northern India, possessed of hardiness but of very little else, by forms which possess this and yet carry to a greater or lesser degree higher economic characters as yield, sugar content and the like. In sugar-cane it may be noted that reproduction is vegetative i. e. by cuttings, and the lengthy process of fixation of character as the outcomes of the cross is not essential as in seed sown plants. Other examples of improved types now in use and owing improvement to hybridization are the newer Pusa and Punjab wheats, paddies of the United Provinces and

elsewhere, ground-nut in the Central Provinces and Madras, and cottons in Bombay and the Punjab.

Improved types whether by selection or hybridization have generally a limited zone in which they are improvements over the local forms. The Pusa wheats for instance are valuable in the Gangetic alluviums but do not show marked superiority in the black cotton soils. The linseeds which are definite improvements over the local forms in the Central Provinces often prove quite the reverse in the sub-montane areas. A cotton which is of outstanding merit in the Punjab is more often than not useless in Gujerat. It thus follows that plant improvement has to be catered for by numerous plant breeding stations in order to make any wide-spread progress and this also accounts for the marked necessity of experimental farm trials and even village plot trials before a new form is liberated.

One of the great difficulties in selecting what to introduce is associated with continuous pull that exists between quantity and quality. A high yielder is usually an easy proposition. The cultivator sees this on the threshing floor and in so many more maunds at the old price. The obvious size of the Coimbatore canes as compared with the old indigenous forms made them one of the best goods in the shop window and the easiest improvements to introduce. In most cases improved yield pays the cultivator best, very largely because, under the condition in which he markets, it is extremely difficult for him to secure the premium on quality or at least the full premium which better quality merits. If, as

an example, one introduces a cotton of much the same lint and staple as the indigenous type but with say 4% or 5% higher ginning percentage, that cotton will have no difficulty in catching on, but, if the introduction is one of lower ginning percentage, but a better quality, it will be no easy matter. The responsible officer may realise that, with a declining market for short staple, in the long run the new type will prove more profitable, but the cultivator lives for to-day not to-morrow. If that longer staple is going to have any immediate acceptance it is likely to call for the organisation of special marketing arrangements.

Almost all Indian soils are deficient in organic matter and nitrogen while the laterite soils and the red soils are deficient in phosphoric acid and the former frequently so in lime. India has been cropped for hundreds of years with but little direct return. In many tracts yields are low, because they are dependent solely on that minimum of plant food which the soil left to its own devices can annually make available. Probably next to water the shortage of manure plays the greatest part in the limitation of the yields of the cultivator's crop. On the other hand we have the fact that the bovine population of the country surpasses many times the numbers in evidence in other countries and hence there should be ample cattle dung manure. Why this is not so arises (a) from the fact that by far the largest amount of the solid excreta is dried and used for domestic fuel (b) from the fact that the average farmer does not tend to

make as much manure as he could from other sources or indeed to get the full value of what his live stock actually do supply other than the part used as fuel. He relies on the residue, often carelessly collected, with at times in certain areas the folding of sheep on his land, to provide his annual field needs.

In regard to the first of these over large tracts of the country cattle dung is the only available fuel to hand and studies have shown that on the whole it is usually more economic to burn dung with its attendant waste of valuable plant food than to buy coal or charcoal. Apart therefore from isolated areas where the provision of wood or the close proximity to collieries might reduce this demand (a) may be written down as a necessary evil, as there is not much use increasing the outturn of raw food by manuring, if, on getting it, it cannot be cooked. It is thus towards (b) that the greatest drive has been made in village demonstration work.

Briefly these may be stated as

(1) inducing the cultivator to realise that dung is not the only manure; but that by collecting every atom of waste vegetation and passing this under his bullocks and hence into correctly made pits a very considerable addition to the quantity generally available is possible. In short this is covered under the encouragement of 'composting' in some form,

(2) making him realise that the urine of his live stock, if systematically conserved in loose dry earth in the cattle stall or the standing area, is equal to the value of the solid excreta which his conditions compel him to burn,

(3) encouraging, where climatic, irrigation and economic conditions permit, the growth of quick easily grown leguminous species as catch crops for the purposes of inversion or green manuring.

Before glancing briefly at these potential sources of fertility it may be noted that there is another source e. g. night soil or human excreta. This, apart from poudrette or night soil composts, as prepared by certain municipalities in order to get rid of town waste of this description and usually purchased or used by a caste of garden crop cultivators—Kachia, plays no part except indirectly, as in the use of fields round the village for relieving nature, in the manurial scheme of the Indian cultivator. His attitude to this potential supply of fertility, in spite of many experiments proving its high value, is absolutely opposite to that of the Chinese or Japanese farmer, who regards night soil as of essential value, possibly as live stock, cattle and so forth—are not so prevalent, and has in consequence developed a considerable technique in its use. In India the handling of night soil in any form is left to the very lowest castes and, though from time to time one does come across a big man purchasing poudrette and having it applied by these, the rank and file of the farming castes will have nothing to do with it and thirty years of suggestion and propaganda have made no real impression.

Of those referred to earlier it may be said that systematic work in modern composting on Government farms has shown that the total heavy manure available can be trebled and even more over what

it used to be before this was done. Though however the exact system can be applied and is being applied on a number of bigger men's farms, it is often not very easy for the small cultivator to adopt in detail, so that the best that can often be achieved is to get him to make an efficient pit or pits and collect therein anything which comes to hand in the way of weeds and vegetation.

The second, which only implies keeping the earth floor loose instead of hard and periodically changing or adding earth, is reasonably feasible and in a number of the intensive better farming societies, referred to earlier, the writer has found that with a little insistent drive in the early stages the practice can be established and is definitely appreciated.

Green manuring has been the form most largely advocated in field demonstration as a cheap and easy method of improving fertility. As the outcome it is most in evidence in advance of sugar-cane in areas where the procedure in the past was an open fallow, before wheat in areas where irrigation later is feasible, as in the canal areas of the Gangetic alluvium, and before paddy, if either early showers, as in Bengal, or irrigation, as in the U. P. and Madras, render it possible to establish a leguminous plant before the heavy rains set in and transplanting is taken up.

It need not be inferred that the Indian cultivators, certainly the better types, in particular where irrigation exists, do not appreciate the value of manure. It is not so much this but a lack of knowledge of what can increase or replace this which is prevalent.

Such as does exist is applied with care, first to the irrigated land, then to the kharif crop and lastly to a rabi crop. The expectation of profitable return from any manuring is in this order. In view of the general scarcity it may be said that dry cultivated rabi, as for instance wheat on the black soils, never sees manure. In these the maintenance of fertility is solely dependent on the leguminous crops which appear in the rotation.

Profitable application of cakes and fertilizers is practically confined to their use on irrigated crops as an addition to an earlier basal dressing of heavy manure, and this too on the more paying crops as sugar-cane, onion, chillies, potato and the like. On ordinary staple crops these are rarely profitable and at all times speculative, as full returns are closely linked with an effective monsoon. The only exception may be said to be the increasing use of bone meal or other phosphatic manures on the red soils and laterites in which this is noticeably deficient. In irrigated areas there would be an extended use of these, if made available more readily on taccavi or by any low interest credit means, which permit payment after harvest. Lack of ready money is the chief hindrance even in areas where the matter of irregular water supply plays no part.

As has been mentioned, on the really small holdings the country implements fulfil everything required and the introduction of an improved implement, unless it can be secured on loan or hire, would

seldom be economic. As however the holding increases in size and the more so if it is consolidated, the better becomes the expectation of the result to be secured and the more desirable is the inclusion of something which is more efficient. The expansion of the use of iron implements and simple machinery is also influenced by the amount of demonstration in the village, by the efficiency and push of the demonstrator and by the maintenance of an effective repair service. There is a world of difference between seeing an inversion plough at work on a Government farm and operating that plough oneself behind ones own bullocks on ones own soil and with a capable agent beside one to adjust it and to show how it should be handled. There would be many more of the simple implements in use, if there was more village to village demonstration and better salesmanship.

In view of the general smallness of even the economic holding and the lack of machine sense the implement must be cheap and it must be simple, even if simplicity may cut out some of the extras which an efficient man in western farming might appreciate. If it can include by slight adjustment or addition the ability to do several jobs so much the better.

The centres of widest use of modern types of field and yard equipment are in parts of the Deccan and in the canal colonies of the Punjab. Thirty years ago there was scarcely an improved or iron implement in use any where. On the black soils we have to-day the marked expansion of the heavier

forms of inversion ploughs which have replaced the old heavy four to six pair indigenous ploughs of the past in the practice of periodic deep ploughing. Here the use of these ploughs by even a small man is facilitated by their maintenance in numbers by the taluka agricultural societies for hire.

The iron three roller mill for crushing sugarcane has now almost entirely replaced its wooden predecessor all over India. Its efficiency in extraction is too obvious. In the Punjab cheap locally made fodder cutters are to be found in numbers in most canal colony villages. The value of chaffing as increasing the value of fodder is better recognised here than in most places. Winnowers are now a common feature in the wheat tract of the Central Provinces. In the fairly easily worked soils of the alluvial areas throughout India light inversion ploughs built on the Indian model are steadily on the increase. Tens of thousands of these are in use in the United Provinces alone. This last with a light three tyned grubber, like the *Baroda cultivator* or the *Akola hoe*, created to meet Indian needs, is practically speaking all that most of these farms of say five acres and over require in the way of modern field equipment.

The Indian plough is practically speaking a single tyned grubber. There has always been a certain amount of controversy on the economic value of the inversion forms as compared with the indigenous type and of deep ploughing on the heavier black soils. Briefly it may be said that other than for the periodic stirring and the removal of perennial weeds, deep ploughing on these heavier

soils as a regular practice is neither necessary nor economic and that in general the value of the regular use of inversion ploughs is governed by the fertility of the soil and the manner in which this is maintained. Where soils are poor and the return either by manure or the presence of leguminous crops in the rotation is non-existent, regular inversion ploughing by stimulating higher yields temporarily will eventually be prejudicial. Otherwise there is every thing in favour of their wider use.

Apart from better tillage and the means of increasing fertility, demonstration has only but occasionally caused alterations in the methods of cultivation. any radical changes in field preparation or planting methods. Examples are to be seen of the gradual extension of line sowing in kharif crops accompanied by bullock hoeing, a practice largely restricted to Southern India, in parts of Northern India as replacing broadcasting or sowing behind the plough and in the marked improvement in certain tracts in the planting of sugarcane, the adoption of ridge and furrow planting and a much wider spacing between the lines, as called for by the bigger size of modern cane. These types of innovation together with green manuring can only be effected by definite intensive work in the villages themselves.

The most reliable defence against insect and fungoid attack is the sowing of types immune to attack. Protection against insects and fungoid attack. These are by no means readily available in many crops, though gradually protection by such means is

becoming available in regard to certain crops and certain sources of loss. Thus for example, B. D. 8, a cotton suited to the soils in Gujerat north of the Nerbudda, is immune to Wilt, a common disease of the heavy black soils and another cotton, Jarilla, is equally effective in resisting the same disease in Khandesh. Among wheats, certain types have been evolved, which, if not immune, are at least more resistant to Rust attack than local varieties, while work in the Punjab shows that certain cotton types are much more resistant to the attack of Jassids than others. In the main however defence must still be sought by alterations in tillage practice, new introductions into field practice, and treatment of the seed or of the growing plant. In certain cases the individual can defend himself. Thus the treatment of juar seed prior to sowing with a solution of copper sulphate or dry copper carbonate or fine sulphur dust will eliminate damage from Smut and the value of dusting the cumin crop with sulphur has proved so obviously easy and effective as to have become an established practice in north Gujerat. Again, dusting with sulphur is frequently employed to protect many orchards from the loss caused by the mango hopper. In other cases, however, full effect can only be secured, if everyone in the area co-operates either in applying the treatment or in taking defensive action. This is a much more difficult matter to achieve. A great deal can be done by intensive propaganda to secure wide-spread application and indeed such is necessary so as to convince farmers of the need, as exemplified by the high percentage of entire cotton plant removal after

harvest secured in Broach and parts of Baroda State as a means of eliminating spotted boll worm, a pest hitherto responsible for a loss of from 16% to 25% of the crop; but complete adoption will, as in other parts of the world and as in other cases of the prevention of noxious pests, call for legislative action. Thus it has been abundantly proved that the damage caused by the Pink Boll worm on cotton, can be prevented by the systematic preheating at the ginneries of all seed either held for sowing or feeding purposes in any tract in which the pest is in evidence as in the cotton area of the United Provinces, that a great deal of the damage caused by Stem Borers on Sugarcane in the Gangetic alluvium is preventable by early removal and destruction of the residues of the previous crop before the advent of the rains, and that the Katras or hairy Caterpillar which is responsible for a vast amount of damage with the advent of rains in Gujerat and other areas can be controlled by a systematic campaign of light trapping and picking, if everyone co-operates for this purpose; but any application of such measures to be effective must be wholesale and on this account are unlikely to be adopted unless made compulsory by legislation.

As is indicated in the early part of the chapter, the attention of the departments

of agriculture has been for the most part devoted to the devising of means which can be

applied by the individual farmer to enhance the yield and the market value of his products. With

the exception of certain examples of co-operative defence against insect pests or disease, as referred to in the last section, there has been but little advance on problems which call for attack on an extended front or any attempt to secure community adoption of an extensive programme of soil conservation, agricultural planning and the utilization of individual lines of improvement in a combined fashion. It is only for instance within the last few years that any appreciable attention has been given to the widespread loss, often of intensive character, arising from soil erosion and to the need for a closer study of soil conservation and the utility of the various methods, arboricultural, agricultural and mechanical, whereby this may be achieved.

The dry farming experimental schemes in operation under the auspices of the Imperial Council of Agricultural Research in the Punjab and in parts of Southern India, though directed towards the conservation of moisture, also offer some protection against soil erosion under the conditions in which they operate. Again, here and there on bigger farms evidence is to be seen of a local approach or realization of the need for action, but with the exception of the work controlled by the Forest Department in the foothills of Siwaliks in Hoshiarpur District in the Punjab and the field bunding work in Bijapur and Belgaum districts of Bombay, there have hitherto been no organised attacks on the problem over substantial areas, as have been undertaken in the United States.

The possibilities offered by zonal agricultural improvement schemes have recently received the

attention of the Imperial Council of Agricultural Research and the Indian Central Cotton Committee as a means of emphasising the advantages of co-ordinated effort in several directions of improvement simultaneously. Otherwise the only approach to this on any scale is the development in evidence round the State tube-wells of the United Provinces where the advantages of remodelling the village fields, consolidation of cropping, better rotations, better seed and improved tillage practices and better marketing of the crop, begun some five years ago, are in evidence on a substantial scale. This condition was rendered possible by the provision of irrigation in an area hitherto dry and the ability of the department to take advantage of such changed conditions among farmers, new to these and unwedded by generations of accepted practice to an established farming system.

Age long custom and the small size and scattered character of most holdings do not tend to make the uptake of operations of various kinds on co-operative lines over substantial areas easy, though it is abundantly clear that something of this kind is needed, if the full advantage of what research and experiment have proved effective are to bear full fruit and if the one great asset of the farmer - his soil - is to be preserved to him.

CHAPTER V

INDIAN LIVE STOCK

Cattle and buffalo, the working bullock, its weaknesses; departmental activity in improvement, cattle breeding and food supplies. The dairy industry, milk production, milk and its products. Sheep and goats. Poultry. The veterinary service, its structure and work. Recent attention to live stock problems.

India has an enormous live stock population; Bovine (oxen and buffalo), Ovine (sheep and goats) and other classes (as horses, donkeys and camels). On census figures the number of the former including those of Indian States is approximately 190 million, those of the other main groups being 90 and 5 millions respectively. The world's bovine population is 690 millions. Thus India carries nearly one third of the world's total. The number is approximately 300% greater than that of the United States and the Soviet Union, the next largest possessors, and thirty times that of the United Kingdom. The value of their production, even though that of the individual is low, is in the mass very considerable. Thus the total annual milk products of the country are estimated as worth rupees 300 crores per annum, roughly equal to the value of the Indian rice crop and three or four times that of wheat, while hides and skins are worth rupees 40 crores (a value greater than that of the sugar industry). To this must be

added the fact that on these the whole of cultivation rests, representing in bullock labour an expenditure of between rupees 450 and 500 crores, and such fuel and such addition to soil fertility as is normally made for which a value of rupees 270 crores has been assigned. At a rough estimate we may say that in actual value the industry contributes about rupees 1,000 crores to the agricultural income of the country.

This bovine population is represented by two groups, cattle and buffalo. In general the first are of primary importance as supplying the work needs of the country, though in certain breeds the female can be of considerable value. The second is predominantly the provider of milk and ghee and other animal products and the male only figures as a worker in the rice tracts. On a rough average the female buffalo yields rather more than twice the milk of a cow at each lactation.

Of the total bovine population in British India 21% are found in the United Provinces, 16% in Bengal, 15% in Madras and but 8% in the Central Provinces and Bombay, while examined in ratio to population and cultivated area there is a considerable divergence in the intensity. Thus in the bigger provinces the ratio per 100 of the population is 80 in the United Provinces and 49 in Madras, while examined on cultivated area it ranges between 105 per 100 acres in Bengal to but 36 per 100 in Bombay.

Definitely the poorest and most degenerate stock are associated with the areas round the head of the Bay of Bengal. They appear to coincide with

the laterite formations, poor in lime and phosphate and the areas of highest general rainfall represented by the east of the Central Provinces, Bengal, Assam, Bihar and Orissa. The large figure per hundred acres recorded in Bengal is chiefly on the score of work stock. As the animals are poor, many have to be maintained.

As one moves on to the drier tracts of Central India, Bombay and Northern India very much better types are in evidence both in cattle and buffalo.

Most provinces have one, two or more distinctive breeds, though the actual number of cattle in the villages which carry all the distinctive features of a particular breed are relatively few, a condition which becomes more in evidence as one moves away from the breeding centres. These breeds are fairly clearly divided into those which are purely bullock or work stock producing, the male progeny being of importance, and those which are definitely valuable because of the milk yielding ability of the female. Again, among the work breeds some are valuable for heavy draught and others for work in which rapidity of movement is the strongest characteristic, being lighter in the body and longer in the leg. Certain of the essentially bred-for-work breeds, however, if carefully selected and properly fed, are capable of producing cows with a fair to good milk yield.

The Sindi and Thar Parkar (Sind), the Sahiwal (Punjab), the Gir (Kathiawar), the Ongole (Madras) are the best known milking breeds,

while the Goalao (The Central Provinces), the Krishna valley (Bombay-Madras), the Amrit Mahal (Mysore), the Harriana (Punjab), Malvi (Central India), the Kankrej (Gujerat), are more important for work of different types. The Malvi is a typical heavy weight plough bullock, at its best in the preparation of the rabi black cotton soil, while the Goalao, Kankrej and Amrit Mahal are examples of the fast moving type particularly suited to the rapid shallow cultivation and hoeing requirements of cotton cultivation and quick cart work. The above selection does not attempt to cover all the local breeds to be found from province to province. The popularity of this or that breed in any one locality is largely governed by the type of farm work and in particular the general depth of ploughing required. It is also influenced by the hardness of the breed.

Of the above, the Malvi, the Goalao and Amrit Mahal may be selected as examples of purely work breeds, while selection among the Hansi Hissar and Kankrej will secure cows capable of a very fair yield of milk. Probably the Kankrej is the finest breed for general agricultural purposes in India.

Most provinces have a breed of some kind.

Though they thrive well in districts of heavy rainfall, the best buffaloes are to be found in districts of moderate to light rainfall. The best known is the Murrah or Delhi buffalo from the Rohtak District, which is common in the Punjab, Western United Provinces, Rajputana and North Sind. It is a heavy built type

with a marked ram like horn and capable of 40-50 lbs. of milk in a good specimen. Others are the Jafarabadi (Kathiawar), a very badly shaped animal but capable of giving upto 30-40 lbs., the Surti or Charotor breed of Gujerat, a definitely smaller buffalo, but the mainstay of the Gujerat milk industry as dependent on the maintenance of two or three of these by every substantial cultivator, and the Mehsana, a breed which is in all probability a cross between the Murrah and Surti. The Mehsana buffaloes are good yielders and not being so heavy are more economical than the Murrah. These thus with the Delhi breed provide the big Bombay milk stables with their milk animals. Over 14,000 of these are entrained yearly from Mehsana to Bombay for this purpose.

The existence of these last three breeds round their corner of India probably accounts for the strong dominance of the buffalo as the milk producer in Western India. The Deccan and Central Indian breeds are marked by longer pointed horns and, relative to the above breeds, are poor yielders.

The total number of ordinary cattle vary, as has been noted, from province to province, though the ratio of bullocks to cows and other cattle is fairly similar in spite of wide differences in conditions. This indicates a general similarity in the method of management. The number of cattle in a district is regulated by the need for bullocks. The worse the conditions for rearing the cattle the more cattle of all kinds does the

Factors leading to the large number of poor animals.

cultivator tend to keep so as to get these bullocks. This condition can only lead from bad to worse, as the more the cattle in a given tract the greater the drain on the natural or cultivated food supplies. It will generally be noticed in India that the greater the amount of what one may term free grazing, the more the animals and the worse the general standard.

The village bullock is provided from two sources, the professional breeders and the cultivators' own cow or cows. The former inhabit the less populated or cultivated tracts as Central India, parts of the Punjab, Sind, Kathiawar, Northern Gujarat and the like. The latter are found all over the country but relatively less so where professionals are dominant. Thus in Northern Gujarat it is relatively rare to see the cultivator in possession of cows. In the Gangetic valley the work stock are partly home bred, partly brought in by dealers from the Punjab, either the products of the professional or bought up from the cultivators. In the Eastern Central Provinces they are for the most part home bred. In general the home bred village product is a fairly miserable animal, the outcome of uncontrolled breeding with immature or degenerate sires and insufficient feed, as it depends for this on an overcrowded common grazing area, producing little or nothing, and on what can be gleaned from the harvested crop. The product of the professional breeder in a breeding tract is relatively speaking bred i. e. the sire he keeps is selected. As his young males are castrated and sold off, there is not

the harm in evidence from immature mating as in the mixed male and female population which wanders out from the average village to graze as a herd. If the monsoon is favourable there is probably a fair supply of grazing, but his stock, like anything that has not some special fodder or cereal straws or other reserve behind it to tide over the lean season from March to July, suffers in development from such shortage. In the past in this semi-nomadic method of cattle raising it was probably much easier to feed live stock than it now is. There is no doubt, that at any rate in certain of these tracts, the areas of the free unowned grass lands are diminishing under expanding cultivation and that what is left is not of the same quality it once was. It thus raises new problems for the future, as the bullock of India, except in relatively rare conditions, depends on grazing from the day he is weaned till he approaches a service age.

The clearly marked defects in the Indian live stock industry are uncontrolled breeding, poor sires, badly managed grass lands and lack of steps to safeguard against the inevitable bad season when grass is short. These have been realised from the earliest days of the Department of Agriculture to whom live stock improvement was entrusted in all provinces except the Punjab.

From 1906 to 1920 cattle breeding rested with the local Deputy Directors and in most provinces cattle breeding farms, handling the local breeds of

importance associated with the province, were started, often on much too small a scale. It was not till the re-establishment of the service after the European War that the necessity of employing a Live Stock Officer, devoted entirely to this work and thus able to ensure some semblance of the all essential necessity of a continuous policy in the separate herds, was appreciated and the necessary appointment made in most of the major provinces. At this time or shortly afterwards most departments materially increased their herds and were in a position to provide bulls in increasing quantity. There are thirtynine cattle breeding farms in India. In the Punjab breeding at Hissar and elsewhere had the advantage of having certain veterinary officers at the earliest stages with a knowledge of stock and of opening on a very large scale. The first real movement towards improving the village live stock showed up here, the bulls from the Government farms passing out to the district boards for village service, accompanied by the requirement that where such a bull was introduced all scrub bulls should be castrated. There is no doubt that this steady output of bulls under partial supervision and with the above proviso has made for considerable improvement in a tract which has the advantage to some extent of some arrangement in the crop rotation for direct fodder crops.

The statement below taken from Dr. Wright's report indicates the progress made in the matter of

annual issue of bulls from Government breeding farms:—

	1925-26	1929-30	1934-35	1936
Assam ...	7	15	36	42
Bengal ...	5	13	30	33
Bombay ...	30	17	28	23
Central Provinces ...	52	41	62	36
Madras ...	20	74	69	103
Punjab ...	320	336	551	616
United Provinces ...	75	145	142	141

The marked superiority of the service in the Punjab is obvious.

In the United Provinces progress has been much better than is shown above. The policy in this department is to reserve its farm bulls for issue in certain reserve tracts where cattle breeding as such is of importance and to purchase heavily from the Punjab where breeding has been in progress so as to provide sires for issue to village herds. The bulls in service at the present time thus read, Assam 200, Bengal 487, Bombay 289, Central Provinces 137, Madras 181, Punjab 5,035 and the United Provinces 3,448. The willingness of the villagers or an individual

to take up a bull and maintain it in reasonable condition is definitely more in evidence in the Punjab and in the United Provinces than is the case in the cotton tracts as evidenced in the Central Provinces and Bombay.

In most provinces other than the Punjab and the United Provinces a bull is issued on what is called the premium bull system, whereby Government meets half the original cost and makes some annual provision for 3 years towards its maintenance.

Very little has been done in the direction of the improvement of grass lands except for a certain amount of research done by the department in Bombay and the Central Provinces, and certain very practical experiments carried out by the Forest Department of the United Provinces on the control of grazing on 'usar' and ravine lands with marked increase in the yield of hay obtained. There has however been a certain amount of activity in the provision of more fodder on the farm, stimulated by the need to increase supplies in the off-season and the increasing interest in the dairy side of animal husbandry, and in the demonstration of silage as a means of carrying over kharif fodders and still more the surplus grass of the monsoon into the hot season. Many new fodders are under experimental trial. Several are of considerable promise, while others like berseem, napier grass, guinea grass and lucerne have now definitely established themselves in different irrigated tracts.

In the main the greater part of the breeding work referred to above has been associated with the improvement of work stock. There has however been an appreciable amount of attention given in most provinces to the question of improving the milk supply of the female, cow or she-buffalo, though the direct issue of milking sires has been much more limited. As has been mentioned earlier though India has certain breeds of cattle with a definite milk producing tendency, the average milk yield of the cow over the country is very poor. In general the indigenous cattle breeder for generations has concentrated his attention on the working bullock. His breeding may not have been on modern lines but his whole direction of selection has been influenced by the male. The female has been the vehicle of production. As a rule, except where the female was rather out of the ordinary as a milker, her feeding interests have ranked last. Her progeny, specially if female, have been deprived of a good deal of her milk and all said and done the cow, however sacred, has not had much of a chance. In certain breeds matters have gone so far that the cow may be written off as unlikely to ever develop any milking tendency. Breeding for work and breeding for milk in their highest achievement are antagonistic and a really first class muscle breed is never likely to attain great milk superiority and vice versa.

Any direct attention in India to breeding for milk has probably been concentrated in the past on the buffalo. In view of the general low esteem in which

the Indian cow was held, though certain of the better milkers, as the Sindi and Sahiwal, were taken up at several centres to create pure bred herds, the earlier movement towards improving the milk supply was by grading with Ayrshire, Short-horn and Holstein imported bulls. This certainly led to enormous increases in the yield of the progeny and became recognised mating in the military dairy herds; but it was clear at a fairly early date that the progeny were particularly susceptible to the many epizotic diseases of India and that for the most part they degenerated in the second generation. As a means therefore of uplifting the Indian cow it was a failure. In the meantime a steady advance in breeding and selection had been in progress at Pusa, Lyallpur, Ferozepore and elsewhere, working on the Sahiwal, whereby year by year the milk yield has steadily increased. Thus the Lyallpur herd has advanced from an average of 5.6 lbs. to 17.15 lbs. per day in twenty two years and the herd at Pusa in twenty years has increased from 5.8 lbs. to 18.5 lbs., indicating clearly that at any rate in the milking breeds very marked improvement was possible.

There was at one time some tendency to try and create dual purpose breeds i. e. seeking high work and high milk efficiency in the same herd, but, though a higher milk yield in the cow can be secured, as for instance in the Kankrej, without effecting the working ability of the male, such increase is but limited, if working efficiency is to remain high. The general trend of cattle breeding policy therefore is likely to be in the direction of the improvement of

certain breeds in the less populated tracts for the provision of bullocks and concentration on certain milk breeds for improvement of this commodity where population is thicker, urban markets available and where the cultivation of fodder crops, a necessity for effective milk yield, may be possible.

Breeding among buffalo has not been so constant or carried on with the intensity of the above and the improvement has not been so noticeable. Possibly the original buffalo started at a much higher standard. The Royal Commission laid considerable stress on the need of much more attention to live stock in general and to the improvement of the Indian cow in particular, a matter which was taken up very whole-heartedly after the Marquis of Linlithgow became the Viceroy.

The estimated amount of milk produced per annum in India is 690 million maunds. In so far as figures are available from certain areas only, about thirty three million cows therein are responsible for 240 million maunds and fourteen million she-buffaloes for 220 million maunds. The milk of the latter is considerably richer in butter fats, at about 8% as compared with 5% in cow's milk, and it thus, though freely used as milk, in particular in Western India, is the predominant source of ghee.

The present day insistence on the necessity to increase milk supplies, in particular those from the cow, is the outcome of a better appreciation of its dietary value and of the extraordinarily low per capita consumption of an important item of nutrition

in evidence in this country. Surveys have shown that, whereas in northern rural India the consumption of milk and its products may reach 15 ozs. per capita per day, in southern rural India and in Bengal and in the bigger cities it is nearer 2 ozs. to 3 ozs. only, giving a probability of only 7 ozs. per capita over the country as compared with 36 ozs. to 60 ozs. in western countries where more attention has been given to the cow. Of the 690 million maunds representing the total output, 215 millions are used as fluid milk, 364 as ghee, 52 as *khos*, 26 as dahi, and 10 as butter of all kinds. Both milk and ghee, in particular that made available in urban areas, are for the most part adulterated, the former by free resoure to any odd water supply, the latter by admixture cwith other vegetable fats. The general tendency to the wholesale adulteration of ghee, chiefly by the trade, has of recent years received a good deal of attention. The passing of the Indian Agricultural Produce (Grading and Marking) Act in 1937 included the grading of ghee to four grades and the stamping of the containers according to their analysed grade. This and greater attention to food adulteration in the bigger cities have begun to have some effect in reducing an evil which effected the interest of both the original producer and the consumer. At the present time there are seventeen grading and packing stations for this product, through which some 80,000 maund of ghee are being handled.

India exports about 25,000 cwts. of ghee chiefly to Malaya and imports about 8,000 cwts. of butter (an import which has steadily risen from 1,000 cwts.

to the present figure in the last decade), 10,000 cwts. of cheese and 20,00,000 cwts. of various forms of preserved milk, sweetened condensed skim milk forming three-fourth of the whole.

Of the 9,00,00,000 total population of sheep and goats, about one third are to be found in Madras. Sheep and goats. Apart from a certain amount of desultory experimentation with Merino rams so as to improve the fleece of the local sheep very little attention was given to them till after the Royal Commission on Agriculture and the establishment of the Imperial Council of Agricultural Research made it possible to allot funds in certain provinces for breeding work in both classes of live stock. Breeding work is thus of very recent date, though the indications are that working with indigenous material considerable improvements are possible in both. The milk of goats is susceptible of considerable improvement and, as an easily maintained animal, it may play a valuable part in the important problem of the village milk supply, in particular among the poorer classes.

Poultry is another class of live stock which is at the present day gaining in importance. The first active efforts on any large scale developed in the United Provinces shortly after the close of the European War (1914-18). Poultry improvement now figures in the programme of most provinces and States, in certain cases, stimulated by grants made by the Imperial Council of Agricultural Research. The movement towards rural uplift which has been prominent during the

passed few years' has also intensified interest in poultry as a subsidiary industry, in particular in villages where Mohamedan or poorer lower caste Hindoos predominate. The main agricultural castes show but little interest. Very considerable improvement in the laying capacity, size of egg and size of birds as available in the village is possible either by replacement of the indigenous birds or by grading up by the help of cocks of overseas breeds. The White Leghorn and the Rhode Island Red both do well and predominate. The greatest obstacles however to the widest expansion are poultry diseases of which the worst is Ranikhet. This however will be dealt with at the Imperial Institute of Animal Husbandry in process of establishment at Izatnagar in the United Provinces.

The first suggestion of the desirability of a civil veterinary department occurred in 1868, but it was not till 1891 that service took shape. At the present day it consists of 109 gazetted officers i. e. members of Indian veterinary service and the provincial veterinary service supported by 1,650 veterinary inspectors and assistant veterinary surgeons. The strongest force rests in the Punjab with 36 of the first group and 408 of the second, but in this province cattle breeding is included as one of its functions, whereas in most provinces the staff employed on this branch is under the Agricultural Department.

The Royal Commission on Agriculture in 1926 pointed out the entire inadequacy of a staff of this

size for dealing with the injuries and sickness and above all the several devastating epizotic diseases to which the live stock of the country are subjected to and suggested a 300% increase in the first group and 400% increase in the second, if the problem of disease was to be adequately met. At present the ratio is about one veterinary surgeon for every 12,00,000 head of cattle and one assistant in charge of a hospital or dispensary for every 1,00,000.

All the major provinces employ a small staff of fully qualified veterinary surgeons one of whom is the Director of Veterinary Services. The control and payment arrangements of the subordinate services varies considerably. In Madras the dispensaries and district staff are employed and paid by Government. In others the hospitals and dispensaries are paid for by District Boards. In some, as in the Central Provinces, Bombay and the Punjab, the staff is borne by provincial revenues and lent to District Boards while in the United Provinces, Bengal, Bihar and Orissa though paid by local Government the greater part of this is contributed by the District Boards. It will be thus seen, that, though the control of the staff is in all cases vested in the Director of Veterinary services, the freedom with which he can apply them is variable, as there is a greater or lesser influence of dual control.

Veterinary research has been carried on primarily at the Research Institute at Muktesar in the Kumaon hills and has been responsible for much valuable work on animal disease. It

Veterinary re-
search.

provides the greater part of the serum required for the preventive inoculation against Rinderpest. Of recent years most provincial departments have included subsidiary research laboratories and in addition to the normal staff the Imperial Council of Agricultural Research has financed in all provinces Disease Investigation Officers, engaged in the local study of the more important cause of illness, debility and the like.

The principal duties associated with the veterinary service are the control and prevention of the major epidemic diseases, the castration of bulls and the general treatment of ordinary ailments and injuries. The most prevalent infectious diseases are Rinderpest, Hæmorrhagic Septicaemia and Foot, and Mouth disease, though there are a number of others which may cause heavy loss. The progress in control however has advanced enormously. Thus vaccination with goat virus will prevent Rinderpest attack for several years at a very low cost per head. Hæmorrhagic Septicaemia which shows chiefly in buffalo during the monsoon can be prevented by inoculation before the epidemic season sets in. Legislation bearing on the early report of disease and the control of live stock movement in the event of outbreak has also contributed to a better position in the handling of epidemics of recent years. Castration of undesirable males, chiefly pressed in breeding areas, has been doubled in number in the last eight years and a much more general use is made of the services of the local dispensary, to be found in varying numbers in each district than was the case twenty years ago.

One of the provisions made by the Royal Commission in outlining the personnel of the Imperial Council of Agricultural Research was the inclusion with the Council of an expert who would handle agricultural problems and another to be concerned with all live stock problems and schemes, including those connected with breeding, feeding, dairying and veterinary matters, and thus in a position to focus greater attention on the improvement of animal industry in all its aspects. This has led to much better correlation and greater publicity of the needs of the country in this important industry. The Council has further been responsible for the foundation of an Institute of Animal Husbandry, at Izatnagar, largely engaged in matters associated with live stock nutrition and live stock disease, working in conjunction with Muktesar, the running of the Dairy Research Institute at Bangalore, the provision of disease investigation officers and the financing of schemes bearing on nutrition problems, diseases and the improvement of sheep, goats and poultry.

It is certain that schemes concerned with live stock improvement will figure much more prominently in future in the financial expenditure of the country than has been the case hitherto.

CHAPTER VI

INCREASING THE PLANT'S WATER SUPPLY

Need and value of water supplies, improvement, sources of supply, canals, tanks, wells; their development, distribution and relative values. The Agricultural Engineering service and its contribution to improvement in the above. Conservation of water.

As has been indicated, climatic conditions over most of India are arid and rainless or nearly so from October to June. With the oncoming of the southwest monsoon rainfall becomes more or less general, ranging however considerably in degree from the intensely humid conditions of the western coastal belt and tracts round the head of the Bay of Bengal, and those along the foot of the Himalayas where from 55" to 80" may be expected to those where the rainfall scarcely penetrates such as eastern Rajputana, the larger part of the Punjab and Sind and where 4" or 5" may be considered exceptional. In between these we have anything between 50" and 15" of rain according to position. On these amounts the majority of the crops have got to come to maturity, unless aided by artificial supplies. Further, these rainfall figures are average figures from which from tract to tract there may be either a very marked divergence from year to year or the distribution may

be such as to militate against its effective use by the crops. Needless to remark therefore a favourable monsoon is all important and anything which can be done to increase or stabilise artificially the supply of water available for the use of the crop, either then or later in the season, is of inestimable value, as securing the crop in the event of unexpected shortage or making cultivation a possibility where otherwise anything of any value would be impossible.

Irrigation of some kind may be said to be of value all over India except along the western coast line, lower Bengal and those areas in which the black soils, in particular the heavier classes, predominate, either as giving security or permitting the more frequent use of the land and the cultivation of more valuable crops or as enabling a crop of some kind to be grown where it would otherwise be impossible for man to subsist.

The part irrigation plays in the rural economy of different provinces varies greatly, but it is of chief importance in Sind, the Punjab, the North-west Frontier, Madras, the United Provinces, Bihar and Orissa. Of the 52 million acres protected in some form nearly 45 million are in these tracts. Including double cropping 56 million acres of crop are helped out by irrigation or are solely dependent on water of this kind.

The importance in each of these areas is shown below

	Area crop	Area irrigated	Per- centage irrigated	Soil type
Punjab ...	2,74,00,000	1,50,08,000	55.5	Alluvial
Sind ...	51,93,000	41,41,000	80	„
North-west ...	21,20,000	10,10,000	48	„
The United Provinces	3,60,00,000	1,08,00,000	30	„
Bihar ...	1,93,60,000	44,60,000	23	„
Madras ...	3,20,00,000	88,20,000	28	„ and red soils
Bombay and Central Pro- vinces	5,30,00,000	23,00,000	4.3	Black trap chiefly

The chief sources of supply are the irrigation canals, tanks and wells. In the first group we have the canals of Northern India and those of Southern India. The first are primarily snow fed, the main storage of continued supplies being the gradual melting of the winter accumulations of snow in the higher altitudes of the Himalayas. The latter are dependent on perennial rivers of which the source of supply

is the annual rainfall. The irrigation systems vary in construction. There are three types:—

- (1) Those as exist in parts of the Punjab which have been constructed without resource to storage tanks wherein the problem has been solved by withdrawing the water from the river and conducting it along the contour lines.
- (2) Those in which the surplus water, whether the result of monsoon rain or snow is stored by means of dams across the line of flow and gradually released as required, in some cases assisted out by subsidiary reservoirs provided for from side streams. The majority of the bigger schemes and the more recent are of this kind. The Sukkar Barrage on the Indus, the Sutlej Valley Works and the Cauvery Mettar project are examples of the class.
- (3) Those associated with the management of the deltas of rivers, so as to provide a regular supply of water and to prevent the damage which takes place from wandering rivers. They are associated with the South Indian deltas and by this system some 24,00,000 acres of the Krishna, Godavary and Cauvery deltas are given assured supplies.

The largest number of major canals are associated with the Punjab. The oldest is the Western Jumna canal, originally constructed by

Firoz Shah in the fourteenth century, restored in 1817-1847 by the British and improved to its present capacity between 1873 and 1880, commanding an area of about 16,00,000 acres of which about one third can be irrigated each year. Others of importance are the Upper Bari Doab, the Sir Hind, the lower and upper Chenab and the lower and upper Jhelum systems and lastly and of most recent construction the Sutlej Valley, permitting the watering of 5.1 million acres of which about 2 million is perennial and the balance seasonal.

In 1887 the area irrigated was 2.3 million acres while to-day the figure including that of Indian States, fed from the same supplies stands at well over 13 millions acres. The Sukkar Barrage with its canals is the greatest work of its kind in the world; while the dam which provides the Cauvery Mettar system in Southern India is one of the biggest.

Any reservoir which is in a position to hold water collected in its catchment in the monsoon for use Tanks. latis in the gear is classed as a tank. Tanks range from large lakes constructed by Government, such as are common in the Central Provinces, Bundelkhand and elsewhere in the peninsula, to various grades of village tanks, in some cases controlled by the Public Works Department, in others by the Revenue Department and in others again by a village or by a private owner. The total irrigation from tanks is about six million acres.

They are most developed in Madras, where they control about three and quarter million acres. The

crop for the most part protected in this fashion is rice. The fact that the field is under a tank is often necessary to ensure a late or better quality rice being grown. They are undoubtedly of very considerable value but they are seldom really protective in that, if there is a real shortage of rain, the tank is unlikely to fill. Many of the tanks in the Central Provinces and Bundelkhand not infrequently command a considerable area, but the water may not be much in demand, as the location has been governed by the suitability of the site for construction rather than by the character of soil which they command. Thus the possibility on heavy black soil of adding 13% to the yield of wheat on one irrigation, as called for in a normal year, is apt to make but little appeal to the cultivator invited to pay a season's irrigational charges on that crop.

At this point it may be explained that the Government works whether canal or tank are classed as either productive or protective. In the former an irrigation scheme is expected to begin to pay interest within ten years, the latter is not expected to pay. Many of the Punjab canals and the Gangetic canals are definitely productive, those of the former from one source or another paying dividends of about 17%, while the canals in Bombay and the Central Provinces represent examples of protective works. Their value lies in the fact that by their existence it is anticipated that the big remissions in land revenue which follow a real crop failure may be avoided. Most of the tanks constructed by Governments are protective.

Here again as in tanks there is vast variation. At the one end is found the State or privately owned tube-well, tapping deep levels and delivering possibly 30,000 to 36,000 gallons an hour and capable in the year of watering 120 acres of sugar-cane, 60 acres of cotton and 250 acres of wheat and at the other a small hole, 8' or 10' deep, splashing water on to from half to one acre at under 500 gallons per hour. Except for the chain of electrically controlled tube-wells, of recent years, constructed by the United Provinces Government in the electric grid area, covering the seven or eight most western districts of that province and now irrigating a considerable area which the surface canals could not touch, the wells of India are the outcome of private enterprise. Nearly 13 million acres throughout the country owe their artificial supplies of water to this source. The concentration is greatest in the United Provinces in which five and a quarter million acres are so irrigated followed by the Punjab, primarily the eastern districts, with a little over four million acres and Madras with about one and a quarter million acres. These wells are easiest secured in the Gangetic alluvium and in the red soils. In the trap areas they are costly, as the excavation has to be made in rock and to some depth and are speculative in that they depend not on a subterranean water table but on the chances of striking water, flowing in the form of underground currents. In the deep level tube-wells, apart from chance artesian supplies to be found in the sub-montane area of the Himalayas, the power used for lifting the water is either an oil engine or electricity. In the

open wells, if the supply is above 6,000 gallons an hour we may find an oil engine and centrifugal pump. For the most part however, the bullock provides the power on any wells of 15' and greater depth. The means of lift is either the mhote, usually a leather bucket holding 30 to 40 gallons, drawn from the well by the movement of the bullocks down an inclined plane, in general use when the well exceeds 40' in depth; or the Persian wheel, a very effective form of lift when depths range from 15' to 35'. Where wells are relatively shallow, as in Southern India, we find the man power lift, an ingenious device called the piacota, whereby the majority of the manual labour of raising the water is overcome by counterpoising the filled bucket, suspended on the long arm of a lever, by a weight attached to the short arm.

Mention has been made of the existence of an

The Agricultural
Engineering Section.

Agricultural Engineering section in most departments of agriculture. The functions of this section are several, such as the designing of improved implements, the introduction and control of agricultural machinery, oil engines and pumping plants, tractor ploughing and the like, but in most their essential importance is in evidence in the improvement of water supplies from below ground level. The amount done is dependent on opportunity and the strength of the service. Opportunity is at its best in the eastern Punjab, the United Provinces and Bihar, in particular in the second of these. It takes the form of tube-well construction and the improvement of open well supplies. The development mentioned earlier whereby the State has undertaken

the supply of water, derived from depths of 200' to 250', so as to command three quarters of million acres, hitherto dependent largely on the monsoon, may be said to be entirely the outcome of earlier work of this kind done by the agricultural engineering section on behalf of bigger land owners, whereby the extent and distribution of this almost unlimited supply of water over the western districts was ascertained coupled with the development of electric power which facilitated State control. At the present day this agency either on behalf of the Irrigation Department or for private owners is responsible for over 450 new tube-wells per annum while the Punjab and Bihar agricultural engineering sections provide some 250 wells between them. The question of the improvement of existing open wells is only slightly less important. The majority depend on relatively surface supplies. Experience has shown that in the alluvial areas in many instances the out-turn of water from such wells can be improved by about 1,500 gallons per hour and over by boring from 60' to 80' in the bottom of the existing wells. This direction of improvement is most in evidence in the United Provinces, Madras and Bihar. The Engineering staff of the United Provinces sinks over 1,00,000 feet per annum, operating on about 1,800 wells with about 75% success, success being measured by the addition of 1,500 gallons and more per hour to the old supply. Over a period of even five years it will be realised that the addition of over 3 million gallons of water per hour must have its effect on safety and prosperity. Similar results, if not so extensive, are in evidence in Madras and Bihar.

Adding to water is not however the only thing which matters. The better use of irrigation water and the better conservation of the natural rainfall are receiving much attention. It is a well known fact that the standard of farming under a well is usually much higher than under canal irrigation. Possibly to some slight extent this may be due to the water, but chiefly it is the outcome of greater skill and lesser waste in the use of a commodity for which the user has had to work. Well irrigation measured in man power and bullock power, as if paid for, is infinitely more expensive, even with the best types of lift, than from the canal. Canal rates in the Punjab are Rs. 12 per acre for sugar-cane, Rs. 6/4 for cotton and Rs. 5 for wheat per season. In the U. P. sugar cane costs Rs. 10 and wheat Rs. 5 per acre from the open canals, while under the tube-wells, where water is sold not by area but volumetrically, cane will cost possibly Rs. 15 and if irrigated from even a fairly shallow open well probably Rs. 25. Hence we find increased care and greater attention to hoeing and the like. The user of canal water is apt to over-irrigate when his turn comes; but continuous propaganda is having its effect and on the older canals the same volume of water now supplies 30% more land than it did 40 years ago.

The other feature—the better conservation of rainfall in the soil—is most in evidence in those tracts where the rain is often short and irrigation is not available, as in the south of Bombay, Hyderabad and parts of Madras. At least four schemes financed

by the Imperial Council of Agricultural Research have been and are at work, studying 'Dry farming' i. e. the means to increase the water storage in the soil and the selection of crop varieties which make less call on such water in order to come to harvest. The drive towards the greater use of line sowing in Northern India is influenced by the better hoeing thus made possible and the moisture thus retained. In tracts like Kathiawar with rainfall of 15" to 20" many of the principles of dry farming viz. deeper primary tillage, protection from run off by low levees and frequent hoeing, are indigenous.

Weak and irregular supplies of the natural rainfall are among the greatest difficulties the farmer has to face. It is not only that his food supplies may suffer, but it is these calamities which largely contribute to his indebtedness. Furthermore, a limited and seasonal rainfall calls for active work at one time and possibly next to nothing to do for months on end at others, as for instance on the black soils. Hence hours of a nation's time go to waste. Irrigation of any kind, in particular if perennial, helps the farmer to avoid debt and above all it allows him to keep himself busy on his land for the most part of the year. The extension of such facilities by every means possible go a long way towards increasing the national prosperity and to ensuring the State revenue.

CHAPTER VII

THE DISPOSAL OF AGRICULTURAL PRODUCE

The influence of communications, the marketing of the farmers' crops, lack of earlier attention, disabilities of the small holder, steps needed to remedy, recent action directed to creation of better facilities. crop surveys; the marketing development organisation.

The disposal of Agricultural produce may be briefly considered under the main heads *Communications and marketing*.

Good communications and speedier means of transport are of great importance to the cultivator, for on these depend his opportunity of the favourable disposal of his produce and indeed the decision to some extent of what he can profitably grow. The progress in rail and road transport over the last three quarters of a century has certainly influenced in the more favoured tracts the gradual change from the older purely subsistence system to one in which consideration of market demand plays a part and hence to the extension and concentration of industrial crops like cotton, jute, ground-nut and tobacco. In addition improvements of this kind enable the produce to be moved quickly and cheaply to places where demand exists, thus tending to equalize prices for particular classes of produce, primarily

those used in the country. The days have almost passed when after a bumper harvest the produce was sold locally for next to nothing and a short harvest made even necessities unobtainable. Improvement in communication prevents the cultivator being left entirely in the hands of the local dealer in the matter of price, reduces the time and strain on his bullocks in placing his produce on the market, and not infrequently admits of his cultivation with profit of market garden crops or his maintenance of dairy stock as part of his farming interests.

Though progress has been considerable, much remains to be done. The figures quoted below from the Royal Commission on Agriculture, though not possibly exactly the position now, are sufficient evidence of this.

Country	Railway mileage	per 100 sq. miles	Inhabitants per sq. mile
United States ...	2,49,398	8.4	469
Canada ...	40,351	1.	222
Russia in Europe ...	35,528	1.5	3,708
India ...	38,579	2.2	7,894
Argentina ...	23,429	2.	367
Australia & New Zealand.	28,748	.9	238

ROADS

	India's nine major provinces		United States of America	
Density of population per sq. mile	204		31.5	
	Per 100 sq. miles	Per 1,00,000 population	Per 100 sq. miles	Per 1,00,000 population
Mileage of all roads.	20.18	84	80.00	2,550
Surfaced roads.	5.38	22	12.00	383

The importance of further improvement is however fully realised by Government and most Provincial Governments have created Communication Boards. The development and improvement of the main arterial and secondary roads is of course essential and specially so with the rapid expansion of motor traffic; but much is called for in the development of the country roads, the connecting links between the village and the metalled roads and between one village and another, as these are of greater importance to the cultivator. An improved main road is of little use to him, if his access thereto is hampered or at times of the year impossible, as is not infrequently the case on the heavier soils, during the monsoon.

The Agriculture Departments have done much to improve the quality and to increase the quantity of the farmers' outturn; but it is only within very recent

Marketing.

years that there has been any decided movement towards enabling him to get the best price for such improved quality or added outturn. To a certain extent an increased yield on his old basis of price has found him with more in his pocket, but it has been a different matter, when the primary advantage of an introduction has depended on its higher value or reputed higher value per maund on the score of quality with possibly even a reduction in yield per acre to secure this.

To some extent this failure to get an adequate premium on quality has arisen from the absence of a sufficient spread and concentration of the new variety so as to obtain a general reputation for quality over a substantial tract. This difficulty has however been met in certain cases by active propaganda and seed distribution of a variety in a particular zone, supported by such means as special departmentally organised auction sales and attempts at co-operative marketing, a procedure which has been in greater evidence in cotton than in other crops.

The fact however remains that in general the Indian farmer markets his crop under very disadvantageous conditions and, till these can be substantially improved, the full advantage of better yield and still more so better quality must remain difficult to obtain.

As has been emphasised the Indian cultivator is for the most part a small farmer, except in certain areas he is still at heart a subsistence farmer and what he has for sale is small in quantity and intermittent. His inherited experience centres in the working of his holding and not, except in certain cotton growing areas, in

commercial sale. He is seldom in a position to hold his crop after harvest at which time prices rule lowest and, if he could afford to hold his storage facilities but seldom permit him. His standard of literacy is low; he is frequently heavily in debt to the party through whom his produce will reach its ultimate market; his communications, in spite of what has been done, are poor, causing him not infrequently to dispose of his surplus to an itinerant buyer who is probably working without competition and invariably with a better knowledge of the true value of the crop; it is unlikely that he is in touch with regulated markets which are relatively few and hence, if he does market his crop, it is most certainly in a market in which he will be subjected to practices which practically amount to theft—still selling his produce with but little or no knowledge of what the rates at the main marketing centres are.

His major difficulties, as has been pointed out by the Royal Commission, can only be met by improvement in communications, the establishment of regulated markets where abuses can be controlled and the ruling rates fixed and by co-operative combination for sale.

It may be taken that enforced sale to the *bania* in the village to whom the Indian farmer is indebted provides the worst return and that, till the removal of indebtedness makes him a free agent, he is unable to take advantage of any improvements which may be organised. Sale to itinerant buyers, a system which is tending to die out where communications have improved, provides the next worse form of disposal.

Sale in a badly organised local market is better than the above, even though the scales are probably manipulated against him, deductions for charitable and other objects are levied, large samples are taken for which he is not paid and the broker through whom he has to sell favours the purchaser.

The Royal Commission on Agriculture in 1926 emphasised strongly the need for regulated markets, operating under strict rules to induce fair play, standardization of weights and measures, which still vary very considerably from province to province and market to market, better storage facilities, the need of detailed market surveys and the appointment to the department of a Central Marketing Expert and like officers in the provinces so as to cope with the position.

The Central Banking Enquiry Committee pointed out the need for some central agency to advise and assist in co-ordinating provincial activity, particularly in the case of agricultural produce intended for export, as these with perhaps the exception of the oil seeds have frequently been the object of adverse comment on the score of adulteration, dirt and inferior processing. This organization came into being in 1935, when the Government of India created a strong central marketing staff and gave financial assistance to Provincial Governments so as to enable the employment of staff under the marketing officers they had already appointed.

The work undertaken was of three kinds, (1) Investigation, (2) development, and (3) fixing of grade

standards. The first was directed to a close survey throughout the country of the most important commodities grouped as sub divisions of crops and live stock products. Certain of these are now completed and others are in process of enquiry. These investigations when completed set out in detail the present system of marketing of the commodity not only as it is found in each of the Provinces and States separately but also in respect of inter-provincial, inter-State and foreign trade. The report on each commodity includes suggestions relative to grade, containers, packing and the like and tentative proposals regarding improvements in market organisation. Development and the provision of grade standards have naturally to await the result of such surveys.

With the close of the survey work, active steps have been taken to improve the position. The Agricultural Produce (Grading and Marking) Act passed in 1937 has already brought into existence twenty-five grading stations for eggs, eight for hides, three for rice, eight for ata and sixteen concerned with fruits and the indication are that many others will follow. Since the establishment of these among other items 15 million eggs and 80,000 mds. of ghee have been graded and marked. Another feature resultant on these surveys has been the fixation in consultation with the traders concerned of standard contracts for wheat, linseed and other crop commodities. With certain minor modifications, the leading associations and trading bodies have commenced trading on the new basis. Greater interest has also been forthcoming from Govern-

ments in the establishment of regulated markets. The staff concerned in this work consists at the centre of an Agricultural Marketing Adviser, six senior and twelve Assistant Marketing Officers. In addition there are forty seven Marketing Officers working in the provinces and thirty-six as appointed by the Indian States. A very definite movement is therefore now operating to rectify the present defects.

The most effective method of enabling the cultivator to secure a full premium for any crop of an approved quality is organisation for the purpose of sale. The ideal is a form of co-operative society which will educate the cultivator in the production and preparation of his produce, will provide sufficient at one centre to admit of grading and will bring the producer into direct touch with the ultimate consumer. It cannot be said that very much progress has been hitherto achieved in this class of work on many crops with the exception of cotton, in particular in Bombay and Baroda State, where, primarily dealing with improved varieties, their sales have steadily risen in value till they now are over rupees eighty lakhs. Other societies for the sale of gur, tobacco, mango and rice are also to be found in the same province-though not in so flourishing a state. In the United Provinces there has been of late a steady growth of co-operative sale of sugar-cane to the factories and also of ghee. Co-operative marketing is also gaining strength in the Punjab.

In general the produce of the farmer which he does not require for home consumption goes on to the market in a raw and unprocessed state. In the absence of cheap and easily applied power, as by electricity, this is unavoidable. Again, the processing of what is to be used in the village, whether it be the grinding of corn, the extraction of oil in the country ghani or the hand ginning of raw cotton, is a slow process when dependent on human or bullock power. Frequently it is a process which occupies time which might be better spent in the field or in maintaining the home. The provision of cheap and easily available electric power in the rural areas, as is now in evidence in the United Provinces Grid area and in Mysore, both recent advances, has its effect in stimulating rural industries, in improving the prices the grower can get and in giving that addition to the gross wealth of the community, which further rural reconstruction and the general betterment of village life call for, if lasting improvement is to be achieved.

The betterment of conditions in rural India can only be secured by the co-ordination of many factors; but the most fundamental and the most important is the increase of the wealth of the farmer, the resultant of a combination of the many features covered in this record which tend to higher production, the better marketing of what he grows and the creation of subsidiary interests which can in some way or the other add, according to circumstances, to his increased

wealth. Given this, there is hope, that agencies which direct the cultivators' attention to better methods of using this new wealth as by thrift, better sanitation, correct dietary, medical relief and the like, may achieve their object and that what they inculcate may in time build up a higher standard of rural life based on the creation of means from within the village to maintain this standard.

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